PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

VOL. XVII CHICAGO, MAY 15, 1913 No. 10

FOR UNCLE SAM'S BOYS

Provision Made for Heating, Lighting and Ventilating the Naval Training Station at North Chicago, Ill., and for Furnishing Steam for House and Cooking Purposes, all from a Single Central Power Plant

IN LAYING OUT THE Training Station and the power plant to supply its needs, it was possible to estimate more closely the ultimate power capacity required than is usually the case, as it was known that the Station would have a capacity of from 1300 to 1500 men, and that the ultimate expansion would be to a capacity of not over 2500 men, as a greater number than this would make it advisable that a new station be started in another locality. Buildings as now provided would care for practically all of the drill, instruction and exercise work, and the only additional equipment would be 6 buildings for dormitories, to be so located as to complete the quadrangle around the parade ground.

Figure 2 gives the architect's special drawing of the arrangement of the station, and Fig. 3 gives the plan of the buildings and shows the run of the underground tunnels and piping for conveying cables, steam pipes and water pipes.

Although it might have been possible to install individual heating plants at a less first cost than would be necessary for the central heating and the supply mains, economy of maintenance and operation called

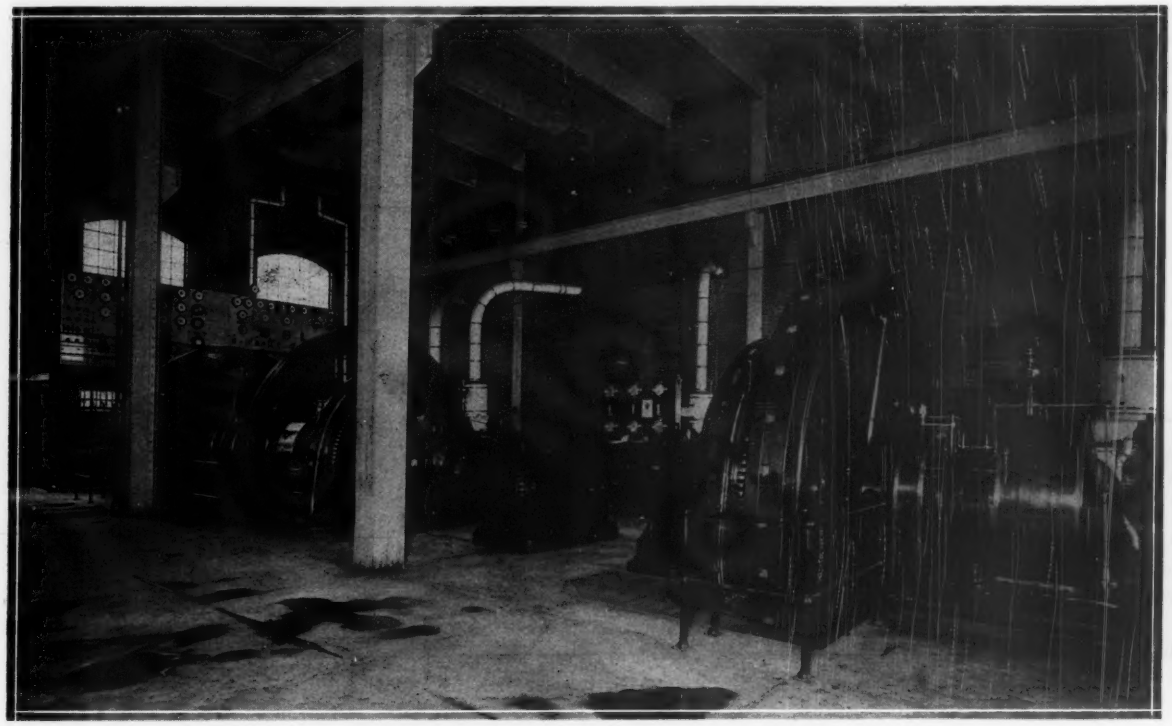


FIG. 7. GENERATING UNITS AND SWITCHBOARD

for the central heating equipment, so that all attendance on power machinery might be concentrated and the control of the entire plant placed conveniently in the hands of one man.

As the water supply would of necessity have to be obtained from the lake, the combining of pumping and electrical plants located the power house on the beach, so that the water might be lifted 70 ft. to the level of the main plateau. As coal must be brought to the power house by railroad, the location of the switch track along the northern boundary of the station's grounds, put the location of the power house at the northeast corner, and 2 timber cribs were constructed, giving a site about 400 ft. long and 150 ft. wide, which permitted also of the location of the water filtering plant near the power house, and at a level 6 ft. above the water, while the power plant was put at 11½ ft. above water level.

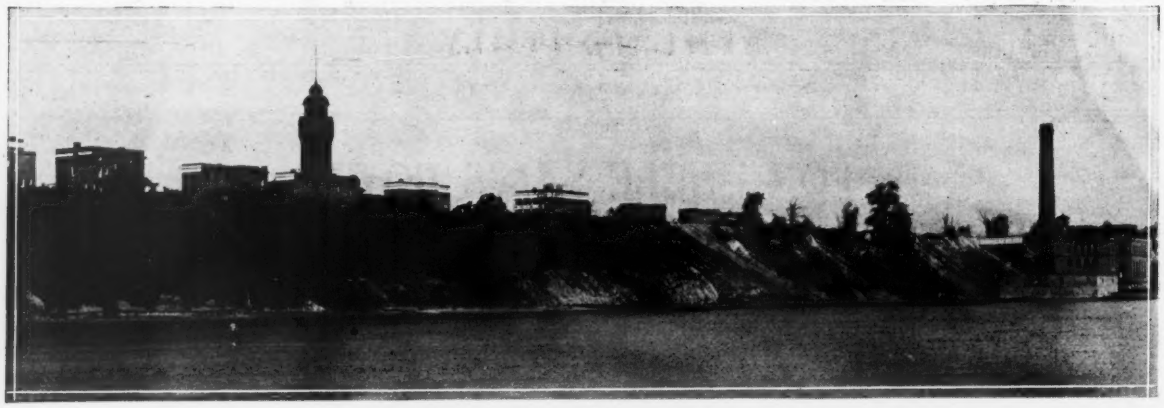


FIG. 1. LAKE FRONT OF THE STATION

The Power House in General

PILING is used for the foundation of the building, the boiler room being at 13 ft. 6 in. above water, and the dimensions 53 by 90 ft., with a clear height of 46 ft. to the roof. Coal bunkers are placed above the boilers, and ash hoppers are located underneath the boilers, to discharge into one-ton ash cars on a narrow gage track.

The engine room is 3 ft. 6 in. higher than the boiler room, and is 26 by 30 ft., with 28 ft. in the clear. Above the engine room is a machine shop, and under the rear of it a basement for exhaust piping, while under the front is the refrigerating room, 16 by 19 ft. and 14 ft. high. Beside the engine room and machine shop are office and store-rooms, with a pump room 19 by 46 ft. beneath, and connecting to the refrigerating room is an ice storage buried in the ground 16 by 19 ft. From the ice storage and pump rooms, a 6000-lb. electric freight elevator runs to a platform on the roof of the power house, from which supplies can be handled over a wagon trestle, to the top of the bluff.

On the landward side of the power house is the stack 180 ft. high by 11ft. 6 in. in diameter. As shown in Fig. 4, the entire construction is of brick, with sandstone trimmings, and material and construction, as in the case of all buildings at the Training Station, are of the best quality.

Load on the Station

IN the buildings are approximately 8000 incandescent lamps, 140 arc lamps, and 340 hp. of motors to be supplied with current. One hundred of the arcs are multiple 110-volt, located in the buildings, and the other 40 are series arcs used for lighting the grounds.

Comparison of the relative advantages of direct and alternating current brought out the fact that the alternating current would save nearly $15,000 over direct current in the cost of the plant, and 2300-volt, 60-cycle, 3-phase equipment was decided upon. The saving in cost was due principally to the difference in cost of lead sheathed electric cables for underground

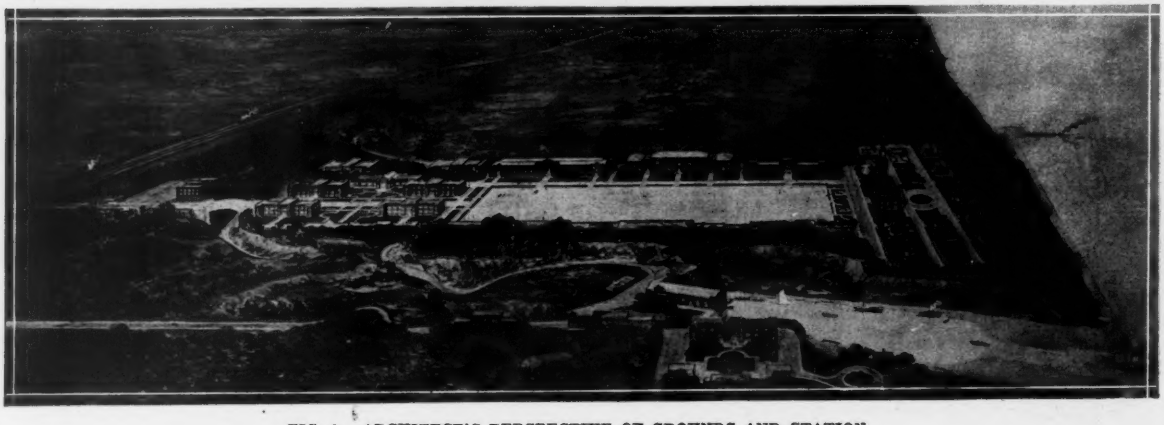


FIG. 2. ARCHITECT'S PERSPECTIVE OF GROUNDS AND STATION

distribution, comparing 220-volt, 3-wire direct-current cables with 2300-volt alternating-current, 3-wire, 3-phase. The high voltage of transmission is carried clear to the service transformers which supply the buildings.

Peak load, which comes in the winter months, was figured at 400 kw. with an average of 160 kw. And the average load for the year at from 100 to 120 kw. It was decided, therefore, to install 3 units of 175 kw. each, with space for a fourth of the same size, in case of expansion of the Training Station. The heating load consisted of about 118,000 sq. ft. of direct radiation, supplied by hot water from the circulating mains, while steam distributing mains carrying live steam, have to care for 15,190 sq. ft. of indirect radiation for fan coils, hot water heaters for domestic and bath uses, including the heating of 1000 gal. an hour for the Administration Building, 10,000 gal. an hour for the swimming pool, 5000 gal. an hour for each of 4 dormitories, 2000 gal. an hour for the Mess Hall, 125 gal. an hour for the Drill Hall and storehouse, 75 gal. an hour for the stable, 125 gal. an hour for the Brig, 225 gal. for the Receiving Building, 250 gal. for each of 6 receiving dormitories, 400 gal. for the receiving galley, and 125 gal. for the power house, or a total of 35,700 gal. an hour for the plant. Also steam is needed for the disinfecting plant in the Receiving Building, for laundry equipment, for drying racks in the main dormitories, for cooking in the main galley, and for the officers' quarters. Except for certain cooking apparatus and the different disinfecting plants where steam at from 60 to 100 lb. pressure is needed, all steam for the house uses is at low pressure of 5 to 20 lb.

For the hospital group of buildings, including hot water radiation and all other purposes, a separate steam line is run, to supply 17,000 sq. ft. of direct hot water radiation, 960 sq. ft. of indirect radiation, and disinfecting plant, sterilizers, domestic hot water and laundry. It was figured that the hot water radiation would require 25,000 lb. of steam an hour, the

FIG. 4. POWER HOUSE FROM THE BLUFF

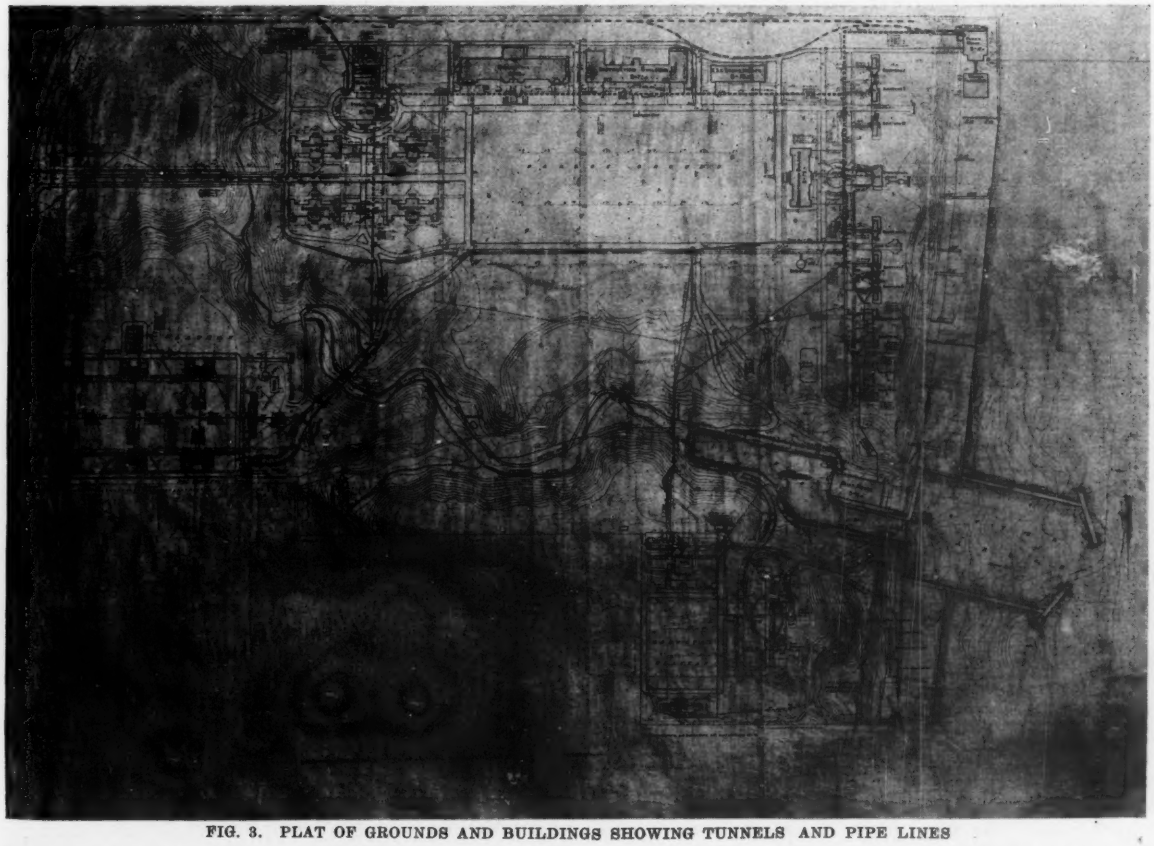


FIG. 3. PLAT OF GROUNDS AND BUILDINGS SHOWING TUNNELS AND PIPE LINES

indirect steam coils, 15,000 lb., the hot water heaters 7000 lb. and other apparatus 5000 lb. with the hospital group requiring 6000 lb. or a total 58,000 lb. of steam an hour needed. In round numbers this would require about 1900 boiler horsepower, and no additional was figured for engine or pump loads, as all steam used for those units is available for the hot water heating load. Accordingly, the rated power on the installation of boilers was 1800, as the boilers are capable of continuous and efficient operation at 50 to 75 per cent overload, giving about 3000 boiler horsepower maximum, which would provide a sufficient number of spare units. It is found that the water supply calls for about 300,000 gal. a day, or an average of 200 gal. a day per individual at the station, and the refrigerating requirements called for the installation of a 13-ton compressor, with a 5-ton ice making plant. The hospital has a separate 6-ton electrically driven refrigerating plant on the carbon dioxide system.

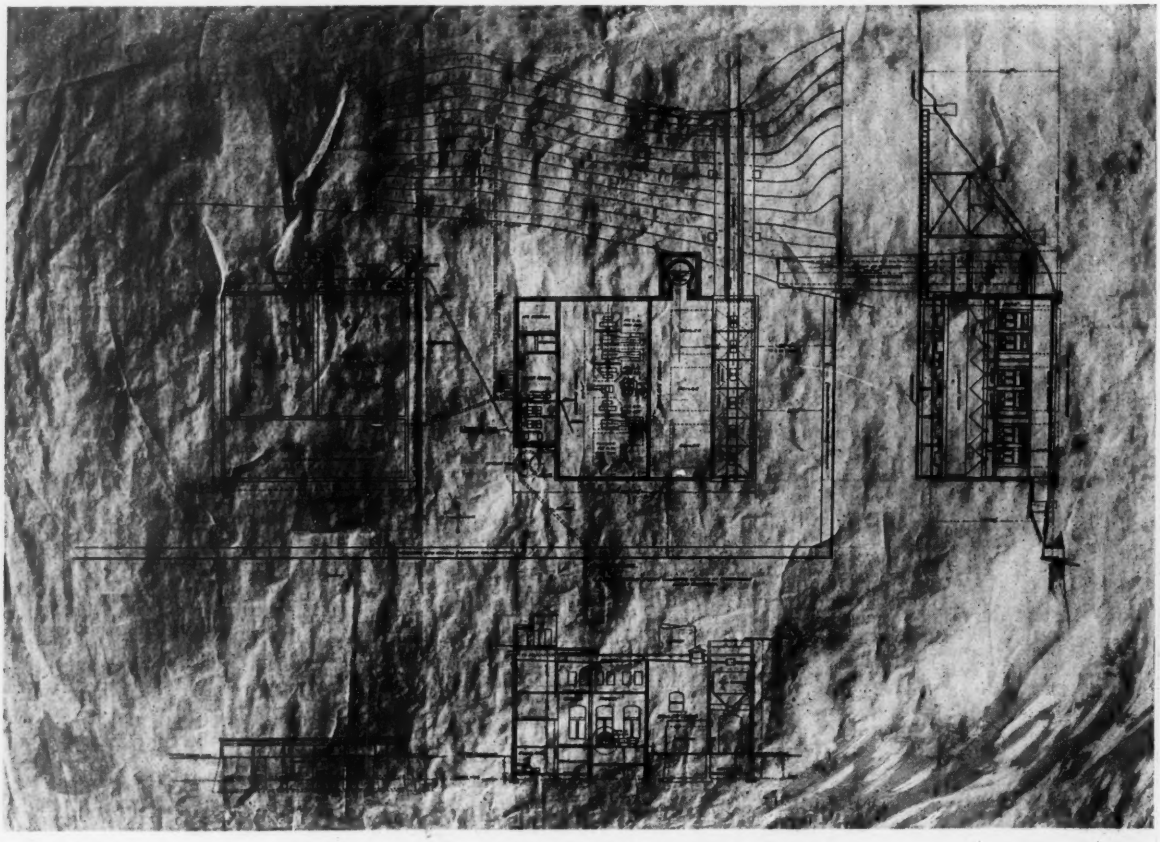


FIG. 5. PLANS AND ELEVATIONS OF POWER HOUSE AND FILTER

Coal and Ash Handling

FROM the photograph of the power plant and the plan drawing, it is evident that the ground level is above the power house roof, so that the railroad is carried over a steel trestle to the roof of the power house and coal dumped into steel hoppers which are suspended from the track. An electrically propelled and operated coal crusher with capacity of 60 tons an hour, takes the coal from the track hopper and feeds by gravity into the coal bunkers of 500 tons capacity situated just below the boiler house roof; from these bunkers the coal passes by gravity through chutes equipped with weighing scales to the automatic stokers and ashes fall from the ash pit to hoppers in the ash tunnel, and are dropped into ash cars. These cars leave the east side of the power house and are raised by a hydraulic ash lift elevator to the level of the ground outside the power house about 7 ft. and are then run along the beach to the edge of the dump, where the ashes are used for filling the beach back of the cribs. The entire movement of coal and ashes, except for the slight lift from the ash tunnel, is, therefore, by gravity.

Boiler Equipment

THE boiler installation consists of 6 Babcock & Wilcox standard boilers, designed for 150 lb. pressure and set in batteries of 2 each. Each boiler has 3000 sq. ft. of heating surface, and a Roney stoker with an effective grate surface of 64 sq. ft. The stokers are set with an arch depth of 8 ft. so as to give a large combustion chamber to prevent the flame striking the cold tubes, and this provision has made it possible by careful operation to avoid all smoke formation. Because the Roney stoker can run with coking as well as with noncoking coal, it is possible at any time that a western is not available, to use an eastern coal, and the outfit as installed is capable of handling all grades.

Test of the boilers showed, at 135.5 lb. boiler pressure, a moisture of 0.26 of one per cent in the steam, and with coal having a heat value of 12,849 B.t.u., and 12.3 per cent moisture, the evaporation was 9.43 lb. of dry steam per pound of dry coal, feed-water temperature being 185 deg. The flue gas temperature

showed 455 deg. and the average draft in stack 0.73 in. and furnace 0.18 in. During this test, the boiler ran at 71.7 per cent of the builders' rating.

Engine Equipment

STUDY of the relative value of high-speed and low-speed engines, resulted in the choice of the Corliss type, and because steam from engines could be used in the central heating system, the simple engine was chosen. Boiler pressure is 125 lb., as this is high enough for the simple engine, and much of the steam load must be reduced in pressure for use about the grounds and in the various buildings. The units chosen were Western Electric generators, of 175 kw. capacity, to furnish current at 2300-volt, 3-phase, 60-cycle, and running 120 r.p.m. These generators are direct connected to Bates-Corliss simple engines, 18 by 36 in., running noncondensing, 2 units being right-handed and one left-handed for the economy of space. Flywheels are 14 ft. in diameter and weigh 25,000 lb., and the steam consumptions per indicated horsepower are 26 lb. at ¾ load, 24.75 lb. at full load, and 26 lb. at 1¼ load.

Careful consideration was given to the desirability of installing a condensing plant for use during the 4 months when heat would not be needed, but it was found that the saving in steam for this period would not pay for the investment, because the lighting load would be small.

At the time of the boiler test above mentioned, the engine showed a steam consumption per kilowatt per hour of 29.2 lb. of dry steam, with initial pressure 121 lb. and an average back pressure of 1.5. A one-half load test showed 47.2 lb. of dry steam per kilowatt-hour, under practically the same conditions.

A 25 per cent overload test gave 37.5 lb. of steam per kilowatt-hour, with 116 lb. pressure external, and 1.5 lb. back-pressure. A later overload test on one of the boilers running at 135.5 lb. pressure, with coal having a heat value of 12,047 B.t.u. and 12.8 per cent moisture, and with average stack draft of 1 in. and furnace draft of 0.53 in., showed a flue temperature of 596 deg. and 8.31 lb. of water evaporated per pound of dry coal. The boiler was operating at 169 per cent of the builders' rating during this test.

For exciting the generator field, 2 exciter units are provided, one being driven from an 11 by 10-in. Ames horizontal simple engine, the exciter being a Western Electric of 47.5 kw. at 125 volts and running at 300 r.p.m. The other exciter set is a motor generator, consisting of a Western Electric 45-kw. exciter at 1200 r.p.m., driven through a flexible coupling, by a squirrel cage, 3-phase induction motor.

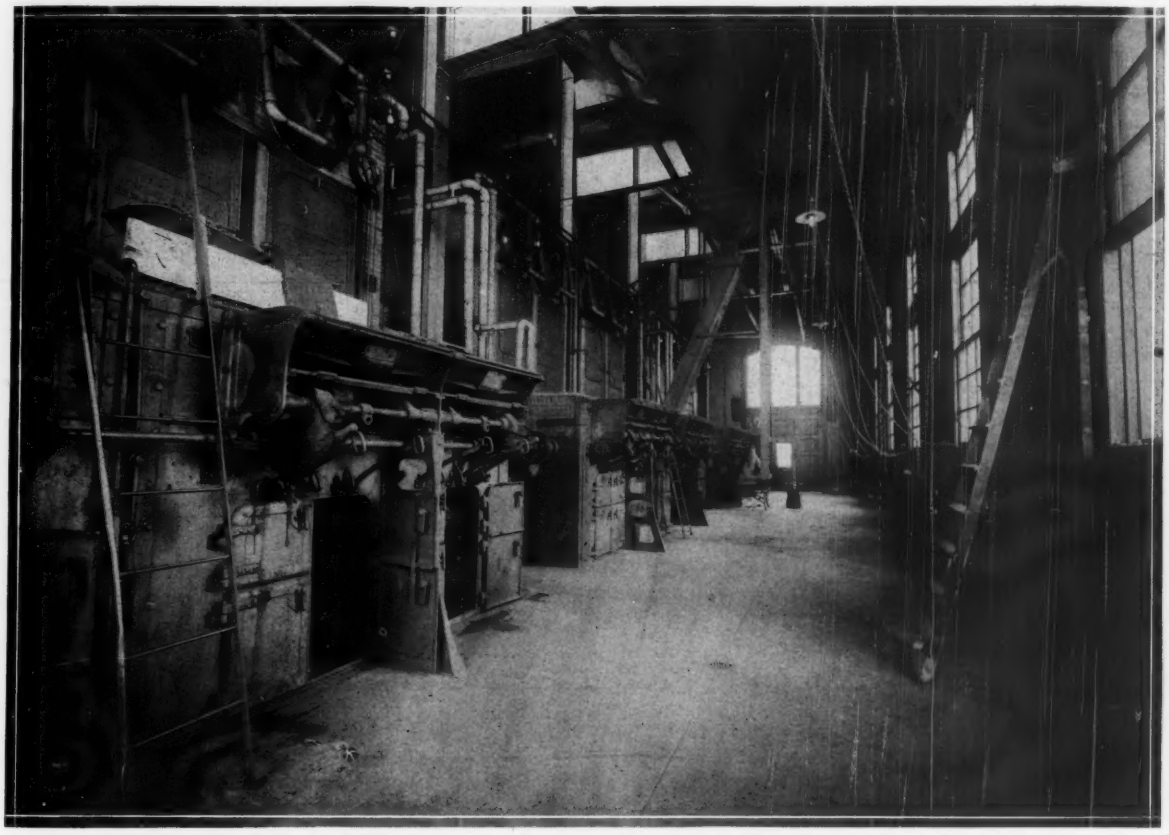


FIG. 6. IN THE BOILER ROOM, BUNKERS OVERHEAD

Switchboard capacity is provided on an elevated platform to care for the entire plant. There are 14 panels, Nos. 1 and 2 for the exciter units, having proper equipment for their control, No. 3 for the induction motor of the motor generator set, Nos. 4, 5 and 6 for the main generators, No. 7, to care for a possible future generator, No. 8, a totalizing panel for recording the entire plant output, Nos. 9 to 13, feeder panels for the different circuits and No. 14 for the control of the outdoor arc light circuits. As shown in the photograph of the engine room, the switchboard

overlooks the engine floor, and all high tension wires and apparatus are kept below the board and protected by wire screen. In this space are installed 3 15-light constant current arc transformers, and 3 15-light regulators, with lightning arrester boards to correspond.

Hot Water Heating System

ALL hot water for this system is heated in the power house, 3 heaters being provided for this purpose. One is an exhaust steam heater, large enough to handle all exhaust steam from all the apparatus in the plant, with 2 live steam heaters in series with the exhaust heater, to supply the extra heat necessary. Closed heaters are used because of the difference in elevation between power house pumps and hot water mains. The pumps are about 55 ft. below the mains, and as the circuit is maintained closed, the 55 ft. drop in the returns balances 55 ft. lift on the outgoing water. The heaters have the steam inside the tubes, and a compartment is provided at each end of the heater, which in the case of the live steam heaters is long enough to permit the removal and renewal of tubes.

Plates and tubes are all of steel, the tubes being 2 in. in diameter, and for the exhaust heater 13 ft. long, 433 tubes giving a surface of 2814 sq. ft. The specifications called for the condensation of 21,000 lb. of steam an hour at 1½ lb. pressure, with a mean difference in temperature between steam and water of 42 deg. The entire exhaust heater is 5 ft. 6 in. in diameter, by 19 ft. long, and carries a working pressure on the water space of 130 lb., the test pressure being 250 lb., and that for the steam space 50 lb. Water connections are for 14-in. pipe, and exhaust steam connection for 16-in. pipe.

In each live steam heater there are 349 tubes, each 6 ft. 6 in. long, giving 1134 sq. ft. of heating surface, the heaters being 5 ft. in diameter and 17 ft. long, with water space working pressure of 130 lb. The water connections are 14 in. and steam admission 8 in., the condensation outlet being 4 in. Supply of steam to the live steam heaters is controlled by a Johnson thermostatic equipment which opens and closes the steam supply on a variation of 2 deg. in temperature of the outgoing hot water.

Condensation from the exhaust heater and from the feed water heater passes through a water seal set in the boiler room floor, and consisting of a 10-in. cast-iron pipe 12 ft. long, to which the 3-in. condensation pipes from the heaters are carried near the bottom. A 4-in. overflow from near the top of this seal carries the condensation to a tank in the engine room basement, which is emptied into a hot well by a 2-in. centrifugal pump driven by a 2-hp. motor, and controlled automatically by a Cutler-Hammer sewage lift equipment. Condensation from the live steam heaters passes to a receiver from which it is drawn by a Marsh pump, controlled by a float valve, and delivering the condensation to the hot well.

Located also in the rear of the boiler room is the feed water heater of closed type, with brass water tubes. The cast iron shell is tested to 75 lb. pressure, and the ends to 250 lb. The heater has 291 1¼-in. tubes, 11 ft. long, giving 1000 sq. ft. of heating sur-

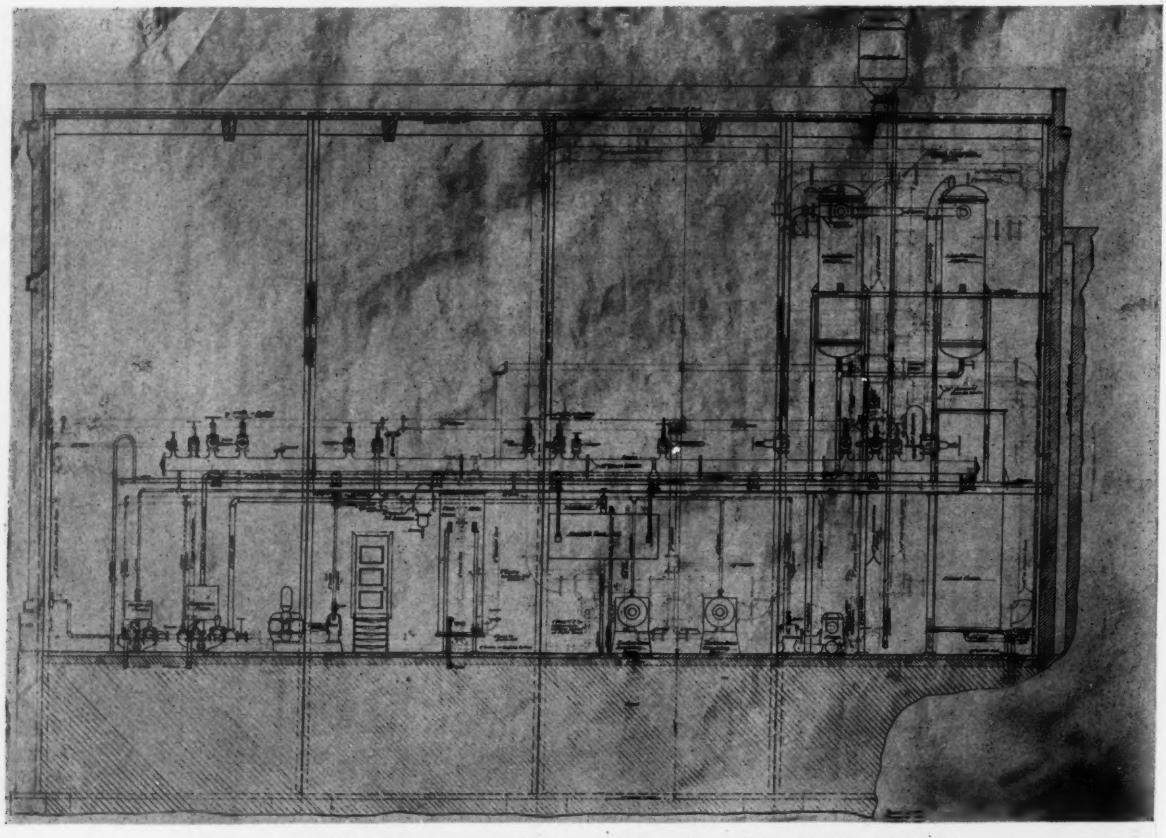


FIG. 6A. ARRANGEMENT OF HEATERS, PUMPS AND PIPING BEHIND BOILERS

face, and exhaust steam from the auxiliary apparatus about the plant is piped to the exhaust steam heater for the hot water heating service, with a bypass to the feed water heater so that if required all steam from auxiliaries may be used in the feed-water heater.

Condensation from the steam heater, separators and high pressure piping is returned to the hot well by a small pump and receiver. Condensation from all over the grounds is returned to the hot well by a special pump except from the hospital steam lines, which have a high pressure return. The hot well to which all condensation is delivered, is a ⅜-in. steel tank, 4 ft. in diameter and 10 ft. long, with a float valve for admitting make-up water, and with connections for receiving returned condensation from all the different sources.

Hot Water Circulating System

PUMPS for forcing the hot water through the heating system of the station are installed in duplicate, each one being able to carry the entire load. The highest radiation is about 135 ft. above the pump, since the circulating system is closed, the lift is balanced by the fall and the friction head alone is what must be taken care of. This amounts to about 160 ft., and the maximum capacity of the circulating pump at this head is 2300 gal. a minute, and with a friction head of 100 ft., the average duty is 1700 gal. a minute.

The pumps are of the volute centrifugal type, with 10-in. connections, directly driven through flexible couplings, by Kerr steam turbines. Casings are cast iron with bronze impellers, and each turbine is rated at 150 brake hp., running at 1700 r.p.m., with steam at 125 lb. pressure. Steam consumption is 37 lb. per brake hp. at full load.

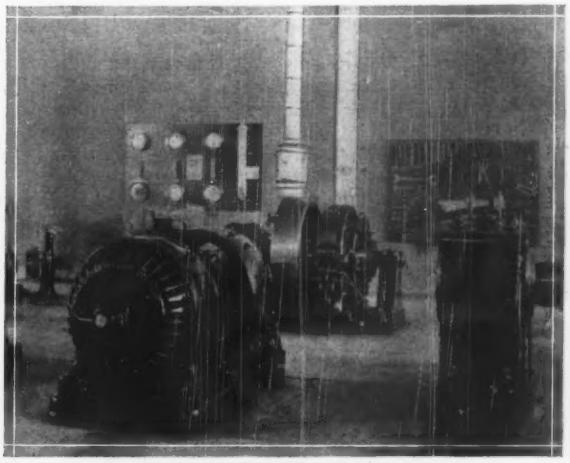


FIG. 8. EXCITER UNITS AND GAGE BOARD

The circulating water is measured by a 14-in. Venturi meter, and condensation from the live steam heater is measured by a 4-in. hot water meter.

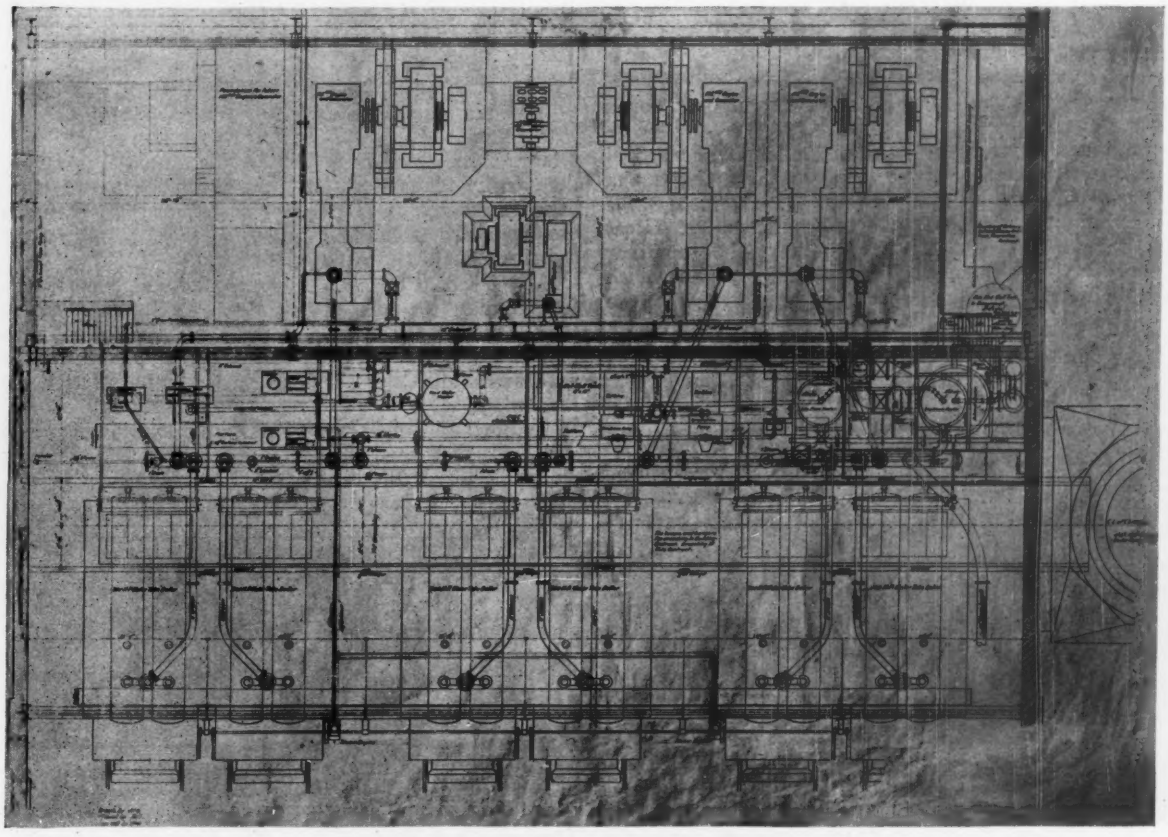


FIG. 8A. PLAN OF POWER HOUSE AND ARRANGEMENT OF MACHINERY

Other Pumping Equipment

FOR feeding the boilers, 2 American pumps are installed, each fitted to carry the entire load. They have 14-in. steam cylinders, 8½-in. water cylinders

(Continued on Page 502)

HEATING AND VENTILATING LARGE BUILDINGS

Types, Construction and Purpose of Special Equipm ent

By Charles L. Hubbard

THE present article takes up the special equipment required where exhaust steam is used, either alone or in combination with live steam for heating purposes. One of the first matters to be considered is the removal of the oil from the exhaust before turning it into the heating system.

While a coating of oil over the interior surfaces of the radiators reduces their efficiency somewhat, the principal reason why the oil should be eliminated is to prevent its being returned to the boilers with the condensation.

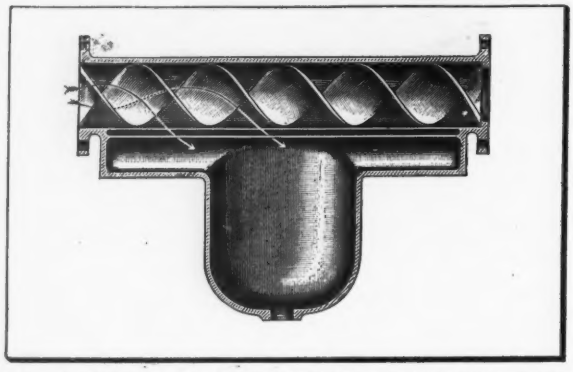


FIG. 1. OIL SEPARATOR WHICH EMPLOYS CENTRIFUGAL FORCE

Separators of the centrifugal or baffle type, connected into the exhaust pipe before it joins the heating main, will usually remove the oil to such an extent that the condensation may be safely returned to the boilers. Great care should be taken, however, to have the separator proportioned for the particular conditions under which it is to operate, for if the steam passes through at too high a velocity, particles of oil will be carried along with it. In any case, the return water should be tested for oil, and if it is found to be present, the condensation should be passed through a settling tank or filter before reaching the feed pump.

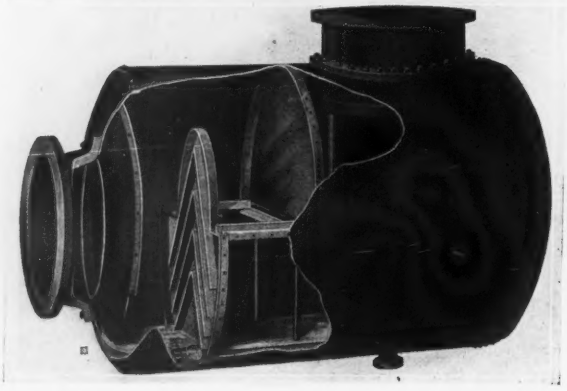


FIG. 3. OIL SEPARATOR WITH EXPANSION TANK

Principles involved in the removal of oil from steam are illustrated in Figs. 1 and 2. The first of these makes use of centrifugal force, the steam being given a whirling motion which throws the heavier particles of oil against the shell of the separator, from which they drip into the chamber or receiver below.

That shown in section in Fig. 2 contains a series of baffle plates against which the steam strikes in passing through. This reduces the velocity suddenly, and changes the direction, thus causing the oil to be caught by the projecting edges of the baffles. As it collects, it drips into the receptacle at the bottom, from which it is trapped to the sump well or sewer. In some types of separators

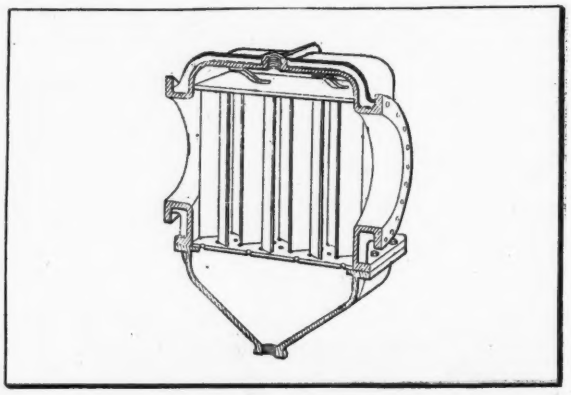


FIG. 2. BAFFLE TYPE OF OIL SEPARATOR

a large chamber or expansion tank is provided to reduce the velocity of the steam and also to equalize the pressure between the strokes of the engine. Such a separator is shown in Fig. 3, the elimination of oil being effected by a series of baffllles arranged as shown.

Large separators should be provided with some means for cleaning the interior surfaces of oil from time to time. In some cases this is done by blowing in high-pressure steam through a small internal pipe having a number of outlets, so that all parts of the interior are reached.

In others the oil is washed off with a solution of potash which is discharged through a perforated pipe running along the top of the baffle plate.

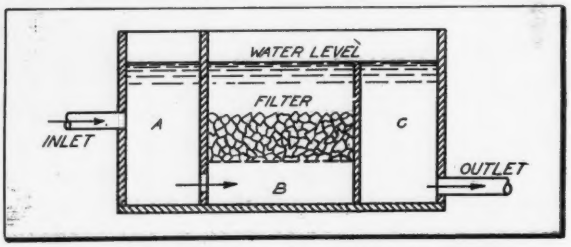


FIG. 4. COMBINED SETTLING TANK AND FILTER

The principle upon which a combined settling tank and filter acts is shown in Fig. 4. The condensation from the heating system enters the chamber A, where a considerable portion of the contained oil rises to the surface. From A the water passes into B near the bottom of the tank, then upward through the filter, and overflows with C, from which it passes to the pump, the outlet being near the bottom of the tank as shown.

The oil which collects on the surface of the water in the different compartments is drawn off through overflow openings not shown in the cut. Filters of this kind are commonly composed of coke, crushed quartz, charcoal, excelsior, burlap, or other porous material which will pack closely, and at the same time present a rough surface to which the particles of oil will adhere.

While feed-water heaters belong to the power side of the equipment, rather than to the heating, they are closely connected with the latter on account of sharing the exhaust steam.

As only a small amount of steam is required to heat the make-up water in the winter season, and only about 1/6 the total exhaust may be utilized in the summertime, when the heating plant is out of commission, it is not necessary to turn the whole amount through the heater. Although there is no particular harm in doing this, it may often simplify the connections if the heater is supplied on the induction plan, as illustrated in Fig. 5. In this arrangement the steam used in the heating system does not enter the heater at all. If the piping is such that all of the steam does pass through the heater there is some danger of its becoming moist, especially if open heaters are used.

With a closed heater, the oil separator may be placed beyond the heater and thus overcome the difficulty, but with one of the open type the steam is made to pass

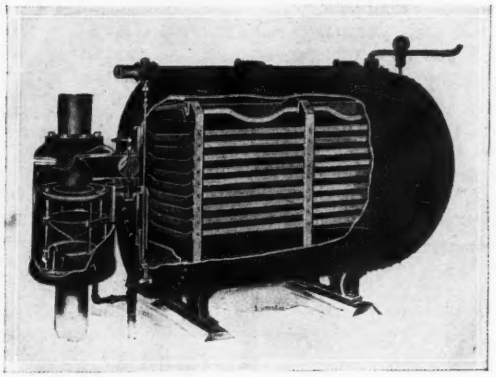


FIG. 5. HEATER PIPED ON INDUCTION PLAN

through the separator first. With a connection like that shown in Fig. 5 any possible difficulty from this cause is avoided.

Figure 6 shows a combined oil separator, feed-water heater, settling tank, and filter, which also serves as a receiver and pump governor. The different parts of the apparatus are clearly indicated in the cut and need no explanation.

The receiving tank and feed pump forms an important part of the heating equipment. The tank in large plants is usually of wrought iron and vented to the atmosphere through a vapor pipe. All condensation which does not contain oil is trapped with this tank and pumped back to the boilers automatically, a balanced valve, operated by a float within the tank, being placed in the steam pipe supplying the pump.

For the average sized plant a tank 36 in. in diameter and from 48 to 72 in. in length is commonly used. Two pumps are employed, each of sufficient capacity to do the entire work at a speed not exceeding about 45 strokes a minute. The capacity is based on the boiler horsepower rather than the heating surface, because all of the water fed to the boilers, both condensation and make-up, passes through the pump. The table gives the average capacity of standard sized pumps at 45 strokes a minute.

Capacity of Pumps at 45 Strokes a Minute	
Sizes of Pump, Inches	Boiler Horsepower
4½ by 2¾ by 4	116
5¼ by 3½ by 5	240
6 by 4 by 6	376
7½ by 4½ by 6	480

Larger sizes than the above may be had if desired. In small plants, combined outfits like that shown in Fig. 7 are often employed. Both the piston and the plunger type of pump are used, the advantage of the latter being the ease with which the wearing parts may be repacked or renewed if the water is at all gritty.

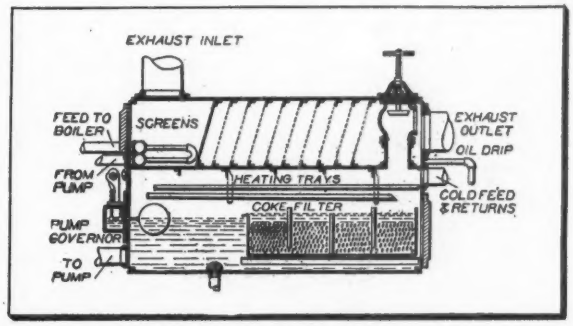


FIG. 6. COMBINATION OIL SEPARATOR, HEATER, SETTLING TANK AND FILTER

The receiving tank is quite often replaced by the open feed-water heater, which is also made to embody an oil separator, settling chamber and filter. A heater of this type is shown in Fig. 8. The main returns are trapped into the body of the heater and fresh water is added automatically, as needed, by means of a float valve. In a general way this heater is similar to that shown in Fig. 6 except for the difference in form.

The pressure in the heating system is limited by the back-pressure valve in the outboard exhaust pipe, which opens when there is more exhaust steam than can be condensed in the heating system.

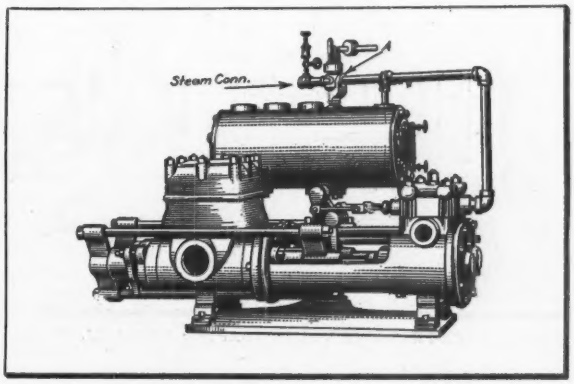


FIG. 7. PUMPING OUTFIT FOR SMALL HEATING PLANTS

Two common forms of back-pressure valves are shown in Figs. 9 and 10. The first of these has 2 port openings, and is adapted especially to the smaller sizes, or where there is considerable difference between the amount of exhaust supplied and that required for heating purposes, so that the valve acts only occasionally. For large sizes, and where there is a more or less constant opening and closing of the valve, the multiple-port type,

shown in Fig. 10, is preferable. The individual valves are small, are provided with dash-pots and held to their seats by light springs attached to an adjustable pressure plate. Provision is also made for a water seal over the valve deck, this being maintained automatically. In ordering a valve of this kind it should always be stated whether it is for use with a pressure heating system or a vacuum system.

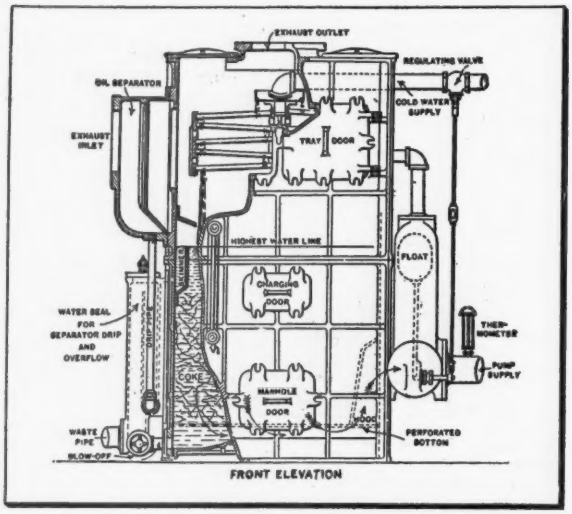


FIG. 8. OPEN FEED-WATER HEATER EMBODYING OIL SEPARATOR, SETTLING CHAMBER AND FILTER

The office of the pressure reducing valve is the reverse of that of the back-pressure valve; that is, it admits live steam to the heating system at a reduced pressure when the exhaust falls below the amount required to maintain the normal pressure.

Other valves make use of springs, pistons, etc., or a combination of springs and diaphragms, but the general principle is practically the same. When valves of the type shown in Fig. 11 are used, the connecting low-pressure pipe should be 4 or 5 ft. in length to give the best results. Reducing valves should always be provided with cut-out valves and by-pass for use in case of repairs. In connection with a reducing valve there should be a pressure gage and small pop-safety valve connected into the pipe on the low-pressure side. The face of the gage should be plainly visible from the valve, and is for use in adjusting the latter for different pressures. The safety valve should be set for a small pressure above the normal carried on the heating system, and its purpose is to give an alarm in case the reducing valve fails to work properly and the pressure in the system rises above that desired. The safety valve may be made more effective by connecting a small steam whistle with the outlet.

While a dangerous pressure in the heating system would probably be prevented by the opening of the back pressure valve, even this might result in a large waste of steam if the condition were not called to the engineer's attention in some special manner.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for drainage engineer and assistant drainage engineer, for men only, on May 21, 1913, to secure eligibles for positions in both irrigated lands and humid regions, in the Office of Experiments Stations, Department of Agriculture, at salaries ranging from $1200 to $2000 per annum. Competitors will be examined in the following subjects, which will have the relative weights indicated: 1. Practical questions on drainage engineering (a) for irrigated lands, (b) for humid regions, 35; 2. Report (to be delivered to the examiner on the day of the examination), 25; 3. Education, training, experience, and fitness, 40. An educational training equivalent to that required for the bache-

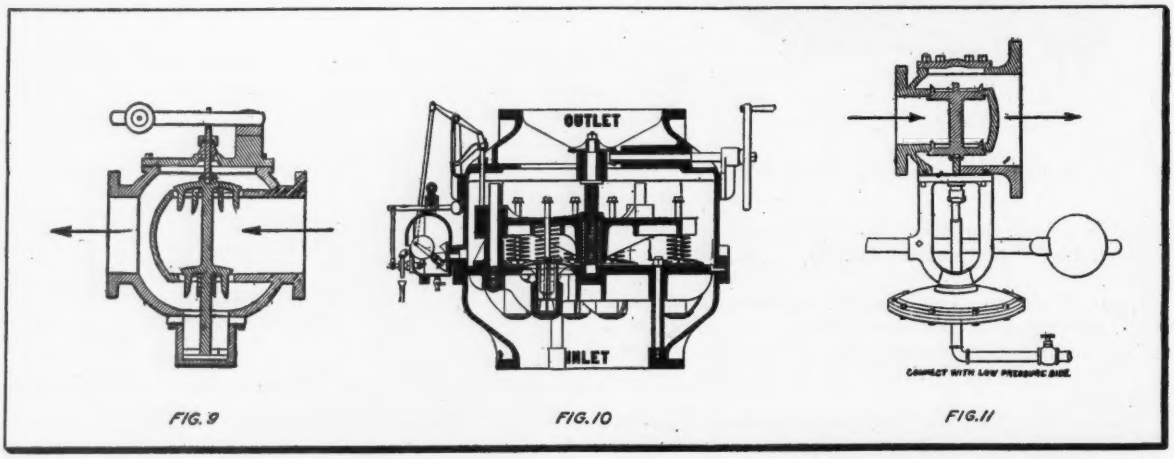


FIG. 9. BACK-PRESSURE VALVE ADAPTED TO SMALL SIZES FIG. 10. MULTIPLE-PORT TYPE BACK-PRESSURE VALVE
FIG. 11. PRESSURE REDUCING VALVE

There are many different forms in use, but the general principle involved is shown in Fig. 11. This consists of a double-ported balanced valve, the spindle of which is attached to a flexible diaphragm.

This diaphragm is exposed to atmospheric pressure upon the upper side and to the reduced steam pressure upon the lower side. By a proper adjustment of the weight upon the lever any reduced pressure may be obtained within the range of the valve, regardless of the initial pressure.

lor's degree in engineering, science, or agriculture from a college or university of recognized standing is a prerequisite for consideration for these positions. Persons who meet the requirements and desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., for Form 131. No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for this examination the title, "Drainage Engineer (Male)," should be used.

SETTING A STEPHENSON LINK MOTION VALVE GEAR

A Badly Mixed Gear and How it was Righted

A POWER plant engineer was asked to set the valve of a little vertical steam engine which served as the motive power for a well-drilling rig. It was equipped with a Stephenson link motion valve gear and the engineer was rather puzzled at first how to go about the setting of it. Seven years had passed since he had had anything to do with a reversing link motion and in 7 yr. an engineer will forget a good deal.

What made the matter worse was that the gear had been tampered with and little of its original adjustment remained intact to serve as a guide for him. He remembered that in such a valve gear the valve must be set with the link in the full gear positions, and, starting with this, the method of setting gradually became clear as he went along.

The first thing to determine was whether the rods were of the crossed or open style. These distinctions are shown diagrammatically in Fig. 1. The crank in the figure stands at C, the crank end center position. Then, if the rods have the position shown in A, they are crossed rods; if as in B, they are the open arrangement.

So the engine was turned to the crank end center for observation. The rods were crossed. The next thing noticed was that the saddle pin, P, Fig. 2, was located in the center of the link. This was an indication that the engine had been designed to operate equally well in both forward and backing motions.

Nor was the engineer grieved to note that the valve stem connected direct to the link block, Q, and not through a rocker as shown at P Q X in Fig. 1. A rocker at this point reverses the motion of the valve with respect to the crank, and, while not a serious complication, yet it naturally modifies the position of the eccentrics on the crank shaft. Instead of occupying the position O E and O F as shown in Fig. 2, they would have been, were the rocker used, diametrically opposite, at O G and O H,

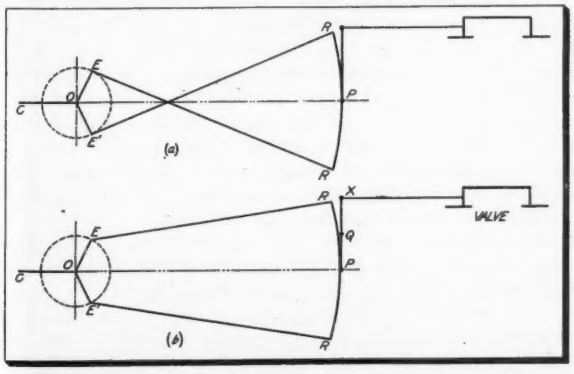


FIG. 1. CROSSED AND OPEN STYLE OF LINK MOTION

respectively. Thus the eccentric which is actuating the valve follows behind the crank at an angular distance equal to 90 deg. less the angle of advance; instead of leading by an angle equal to 90 deg. plus the angle of advance as in the case where no rocker is used.

The foregoing points having been established, all was ready for the valve setting to begin. The first step was to equalize the rods. This was done by placing the link into full gear forward and loosening the eccentric for that motion which will be indicated by A, Fig. 2. This eccentric was then rotated about the shaft, watching the valve V meanwhile and working at l, l^1, its farthermost limits of travel. These points were found in this case to be unequally distant from the center line X Y; or, what was the same thing and more convenient for measuring, in the present instance, unequally distant from the outside edges q, q^1, of the respective steam ports. The engineer thought, and rightly so I guess, that these distances should be equal in a symmetrically set valve. He made them so by shifting the position of the valve along the stem S, away from the farthermost limit of travel toward the center line X Y, a distance exactly half the difference between the 2 distances l q, $l^1 q^1$. The nuts

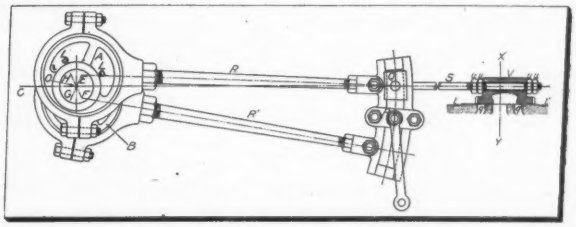


FIG. 2. STEPHENSON LINK MOTION

u, u, u, u, were now set up so as to give the valve just enough looseness to seat itself without permitting any end play along the spindle. Then the eccentric was once more rotated around the shaft, and the distances l q, $l^1 q^1$, proved, under the new adjustment, to be fairly equal. This operation of shifting the valve along the stem so as to make the distance l q, $l^1 q^1$ equal is termed equalizing the travel of the valve.

The same result could have been obtained by changing the length of the rod R, but this length seemed about right, so the engineer didn't want to tamper with it at this stage of the proceedings.

The valve travel was now equalized for the forward motion, and the next thing was to give it the necessary lead.

After making sure that the crank was still on center as nearly as might be, the same eccentric, A, was turned on in the direction the engine was expected to rotate until just the faintest line of opening of the steam port was showing on the end of the cylinder at which the piston was standing. This was the lead. The eccentric was then temporarily fastened and the engine turned over by hand to the other center and the lead on the steam port at that end noted. There seemed little or no difference between the lead at each end so our engineer was satisfied and fastened the eccentric securely by the set screws LL.

He then tried the cutoff by turning the engine by hand again in the direction in which it was to run, until the valve opened the steam port, came back and just closed it again. This was the point of cutoff, and exactly when the port closed, the engine was stopped. The crank was noted to be just a little past the quarter, thus realizing the point of cutoff at a little more than half stroke.

Trying from the other center on around, the point of cutoff occurred at about the same distance from the other quarter, or again at a little past half stroke.

The engineer wasn't satisfied with a cutoff of scarcely more than half stroke, with the link in full gear position; for it didn't seem like giving the engine a fair chance to produce its full power; but that was no concern of his

just then. It was a condition for which the engine builder alone was responsible for the present, at least, he could but continue with the valve setting. It was now the turn of the other eccentric to be adjusted.

Once more the engine was placed on a center and the link thrown over to the reversing full gear position. The valve movement was now controlled by eccentric B, so the latter was loosened and turned about the shaft, as A had been, and the limits of travel l, l^1, again noted. As before they were unequally distant from the ports. To correct them this time the engineer did not disturb the valve on the stem S, but adjusted the length of the rod R^1 instead, until the valve travel was equalized. When this was done he had the equality of rods that he wanted and an equalization of the valve travel as well, for both full gear positions. Now it was only necessary to set eccentric B so as to give the valve lead, and the setting was finished.

Care was once more taken to have the crank on center with the link in the full gear position corresponding to eccentric B. This eccentric was then turned about the shaft, in the direction the engine was to operate until the steam port opening, on the end of the cylinder at which the piston stood, was barely visible. B was then temporarily fastened and the crank turned over to the other center. The port opening, that is, lead, at this end was a little greater than what it had been at the other port. It was evened up by changing slightly the length of R^1 again.

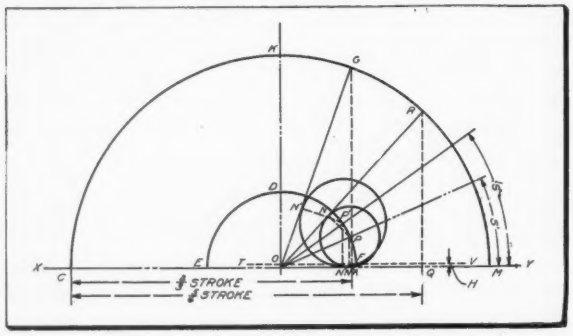


FIG. 3. VALVE DIAGRAM

There was a little more lead now on both ends than was desired so the eccentric was shifted back somewhat to make it less. The screws fastening B to the shaft were then set up securely.

An inspection for cutoff showed that there was little difference in that feature from what had been obtained in the forward gear, so that the valve chest cover was bolted on and the engine turned over to the drill boss.

In a few hours, however, he sought help again, averring that the engine didn't handle itself just right. Again the engineer took off the steam chest cover. Shifting the reverse lever along the quadrant, he found no lead on the valve with the lever in any of the quadrant notches; except in the full gear positions at each end. This led him to think that the rods should be set open style. Evidently former operators were to blame for the rods being in the crossed position in which he had found them.

To correct the error it was necessary to exchange the positions of the eccentric, turning B to operate the engine in the forward motion instead of A which was turned back to take the place of B in the backing motion. This being done, it was necessary to adjust again for equal valve travel and equal lead. These adjustments were made as has previously been explained, so it is hardly necessary again to describe the method. The cutoff was not affected by the change in the rods, and naturally could not be since it was the outside lap of the valve which governed this feature.

When the engine was again assembled it showed itself altogether quick and active under the new arrangements but a practical trial demonstrated a lack of power, just as the engineer had expected, so now he must of necessity do a little remodeling. It was, however, no difficult task. All that was necessary was to reduce the outside lap.

To get at this, the steam chest bonnet was again taken off and the valve removed. Measurement showed that the valve overlapped the steam ports 5/8 in. on each side. The eccentricity O E, O F, of the eccentrics was found to be 1 1/16 in. This was laid off at O E accurately on a line X Y, see Valve Diagram, Fig. 3, and, with radius OE and centers O, a circle E D F was described. This, in the technic of the valve diagram, is termed the valve circle and represents the path of the center of the eccentric around the center O of the shaft. A second radius O C representing the length of the crank to any scale was now laid off on X Y and a second circle C K M described (for want of space the present diagram shows only half circles, these being sufficient to illustrate the present problem), to represent the path of the crankpin. When these circles had been drawn the engineer set his dividers so that they would measure a distance exactly 5/8 in., the amount of the outside lap. He then found a point P^1 on the valve circle so that with P^1 as a center and radius $P^1 N^1$ equal to 5/8 in., the resulting circle would just touch the line X Y. This is the outside lap circle. The line O G was then drawn tangent to the lap circle on the other side cutting the crankpin circle in G. This point represents the position of the crankpin at the point of cutoff. A perpendicular G A to X Y shows C A, the proportion of the full stroke, C M, completed by the piston at cutoff. In this case, it was found by measurement that C A was almost exactly 2/3 of C M.

The engineer decided to increase the cutoff to 5/6 stroke, so C Q was laid off equal to 5/6 C M, and the perpendicular Q R drawn cutting the crank circle in R. From O a line was now drawn to R. The lap circle for this new point of cutoff must, of course, be tangent to O R and C M. A point P on the valve circle was found so that a circle described about it would touch both O R and C M. The radius P N of this circle represents the lap the valve must have in order that a cutoff at 5/6 stroke may be effected.

Measurement showed P N to be 7/16 in., so the valve was cut down by grinding and filing from 5/8 lap to 7/16 as shown by the dotted lines, Fig. 2.

This diminishes the angle of advance as the diagram shows at S S^1, so the eccentrics must be shifted back in order to make the lead right again. This time, however, the lead was made very little or none at all with the link in full gear, as this is the usual custom and no allowance for lead was made in the valve diagram.

The method of allowing for lead in such a diagram is to draw a line T V parallel to C M and at a distance H from the latter, equal to the lead desired. The lap circle is then drawn tangent to this line instead of to C M as shown.

The bonnet was now bolted on the steam chest once more, and the steam turned on. The engine proved readily obedient to throttle and reverse and abundantly powerful.

The engineer's work was done and our story ends.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

SOME POINTS ON MODERN LIGHTING

Practical Hints Given Before the Boston Group of the A. S. M. E. on Arrangement, Types and Placing of Lamps

By Albert L. Pearson

TWO principal forms of electric lamps are in use, arc and incandescent, of which there are several types of each. In the arcs: open carbon, enclosed carbon, intensified carbon, flame, mercury, luminous or magnetite; in the incandescents: carbon, tantalum, tungsten.

The open carbon arc used with high voltage constant, direct-current generators has been displaced in general by the enclosed carbon arc operated in multiple on low voltage direct or alternating-current circuits. The intensified carbon arc is doubtless the best of this series and due to its design the principal objections to the other types of arcs are practically overcome, that is the "traveling" of the arc around the crater causing varying shadows and the change in position of the arc relative to reflectors, thus interfering with the working of any well planned scheme.

Flame arcs are not generally used indoors except in foundries, machine shops with very high roofs or similar places. The light is very penetrating, thus making the lamp an excellent one for smoky places.

The mercury arc is finding a place in machine shops and textile plants, meeting with great favor in the silk industry. The principal objection to this lamp is the color of the light—a cold green. This lamp possesses 2 distinct advantages—great diffusion of the light due in a large measure to the fact that it emanates from a line rather than a point and the line distinction or clearness with which threads or lines may be distinguished.

A fluorescent reflector is being developed which is intended to supply the missing red rays to a certain extent and thus make the light more natural. A new form of this lamp is being developed, the quartz tube, which will compete with flame arcs.

The luminous, or magnetite arc, is not used indoors. This is replacing carbon arcs for street lighting and is used only on constant, direct-current systems.

Of the incandescent class the tungsten lamp is the most efficient, 1.25 watts per candle power as against 3.6 watts for the carbon lamp. The tantalum lamp falls about midway between these 2 for efficiency, 2 watts per candle power. In its present high state of development, the tungsten lamp is practically free from early defects, and works equally well on alternating or direct current while the tantalum lamp gives best service on direct current. Alternating current produces the effect of repeated blows and the filament breaks in a short time, higher frequencies having worse effect than low. This lamp, therefore, should not be used on alternating systems.

In addition to its efficiency, the quality of light from the tungsten lamp is superior to that of other illuminants of this class, most nearly approaching the ideal. This lamp is the greatest competitor of the mercury arc, or Cooper-Hewitt lamp, and is being adopted as the standard of best practice for incandescent systems.

In proper arrangement of lighting systems, there are a number of fundamental principles which should always be followed in making a layout. As the operator is the one for whom the light is provided, he should be given every consideration.

Lamps hung low down which can be adjusted by the operator should be avoided, wherever possible. Not only is he liable to experiment with the lamp and waste time but may interfere with the work of other workmen.

Lamps should be arranged to give uniform illumination at the working plane, avoiding shadows as far as possible and particular attention should be given to the requirements of each machine.

White walls and ceiling are advantageous and add to the effectiveness of the lighting systems. With individual driving of machines it is possible to keep the rooms cleaner than with mechanical or group driving, thus benefiting the lighting system.

On account of the glare, low exposed units should be avoided. In places where it is necessary to have the lamps low down, reflectors which will entirely conceal the filaments should be used. In such cases it is usually necessary to provide lamps close to the ceiling for lighting, shafting, etc., and to overcome the effect of high light and deep shadows.

The position of lamps should be carefully determined, both as to spacing and mounting height. In general the height of the lamp above the floor should be such that with the spacing available the lines representing the angles of maximum illumination with a given type of reflector will cross at the working plane. In a general way the relation of the mounting height spacing and types of reflectors to be used, are shown by a chart in the Reference Tables.

In places where very good light is not required or where it is used for comparatively short periods, obviously it does not pay to invest as much for equipment as in places where light is required for long periods or is depended upon for quality of work.

Lighting systems cannot be worked out as formerly —so many watts or candle power per square foot—but a study must be made of conditions so as to produce a layout which will prove economical and bring results.

The distributing systems should be carefully worked out in order to secure good voltage regulations. Circuits and switching should be arranged in such a way as to eliminate the use of current for lighting in sections not in use.

On low frequency alternating-current systems, small incandescent lamps should be avoided as much as possible on account of flicker, which is more troublesome with the higher efficiency lamps.

CONDUIT WIRING*

Fittings Used and Dimensions of Parts

By O. N. Casey

IN laying out systems of conduit for wiring, dimensions of parts are frequently needed especially if close arrangement must be made to save space. Some of the fittings used are shown and dimensions given in the Data Tables of this issue.

Conduit bushings are used for finishing the ends of runs where conduit work is led to open wiring as shown on p. 362 of the April 1 issue. They are also used to cover the ends of conduit which enter outlet boxes. The dimensions as given have been taken from samples and permit of making allowance for room to turn the bushings in screwing them on, when laying out holes in outlet or panel boxes.

Conduit nipples are used to screw into a coupling for much the same purpose as bushings, and are preferable where compactness is essential. Dimensions are as given in the Data Tables.

Lock nuts are used on conduit on the outside of the outlet or pull box wherever a conduit enters and their dimensions as given in the Data Tables must often be known in laying out panel or outlet boxes, so that proper turning clearances can be provided for the nuts.

Galvanized iron pipe straps are used for supporting conduit surfaces. The dimensions in the Data Tables are valuable, when laying out multiple conduit runs, to determine the spacings necessary between the conduits to allow for proper placing of the straps. The screw hole dimensions enable one to order in advance, screws of the proper diameters to support the straps. Unfortunately, there are no standard dimensions in use by all the manufacturers of pipe straps, and those furnished by different makers will vary somewhat in size. The dimensions given are from one manufacturer's line, and are typical.

(To be continued.)

ELECTRICAL CORRESPONDENCE

LOCATING A GROUND

WE have a big ground on our lines and would like to have you suggest some way of locating the trouble.

We operate a 2200-v. a-c., single-phase generator and run 3 2200-v. wires from plant, the third wire taking care of our street lighting.

Is there any instrument which could be used in finding the ground? O. J.

A. The location of grounds is largely a matter of elimination, a systematic division of the system into convenient parts being the first requisite.

First determine in which one of the 3 lines the ground is. Perhaps the most convenient way to do this would be to reduce voltage of generator to say 500 v. during the daytime when the lights are not in use, and using 5 100-v. lamps in series as a test outfit, as shown in diagram.

Touching the wire to line A would cause lamps to light to full brilliancy, while if touched to B they would remain dark, indicating that there exists no potential difference between B and ground, assuming B is the grounded line. Direct current could not very well be used in this test because of the transformers in circuit.

After the circuit on which the ground is located has been found, several methods are available for discovering in what part of the line the fault is. There are several so called loop tests all depending upon the resistance of the conductor from the power house to the trouble for their solution. These necessitate the use of a Wheatstone bridge and involve a knowledge of the resistance per foot of the faulty conductor.

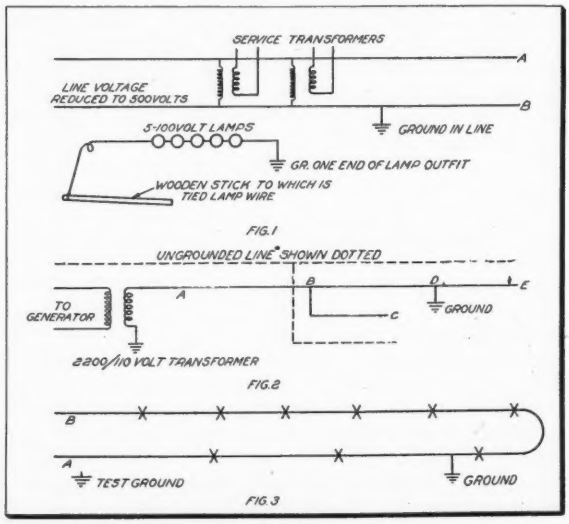


FIG. 1. LOCATING GROUNDED WIRE
FIG. 2. USE OF VOLTMETER FOR FINDING GROUND
FIG. 3. LOCATING GROUND ON ARC LIGHT CIRCUIT

The diagram, Fig. 2, indicates what I believe to be a simpler method; it will not predetermine how many feet from the power house the ground is located, but it is readily used and requires no special instruments.

Connect a transformer as shown, using one of sufficient size to load the line A, B, D, E, nearly to its limit. If desired, the generator can be connected directly instead of through a transformer. In either case, we have almost a short circuit, so that the generator field must be quite weak in order to prevent an excessive flow of current. Circulating current through the circuit A, B, D and through the ground return will establish a potential difference between A and the ground equal to the ohmic and reactive drop in the lines.

For example, if we have No. 6 wire and pass 100 amp. through the circuit, we will have an e.m.f. of about 45 volts per thousand feet of wire. Assume that we measure at A and find 45 volts between the wire and ground. At B we find say 22. We know that we are approaching the ground. At C, on a branch line, a short distance from the main line, we find 22 volts, showing that we are no nearer the ground. Thus testing successively, we reach D where the potential is zero. Beyond D the voltage is also zero. Thus by testing at every block for example,

*Continued from page 363, April 1 issue.

we are able to tell whether we are going in the right direction. As long as we are approaching the ground, the voltage decreases, on branch lines it remains the same as at the place where the branch was tapped off, and beyond the ground we have zero volts.

If care be used not to touch the ungrounded wire, this method might, in case of emergency, be used on lines which were carrying power, if an extra generator were available for supplying testing current.

For arc circuits the procedure is very simple. In the diagram, Fig. 3, the crosses represent lamps. Ordinarily the greatest part of the resistance of such a circuit, and the greatest drop, is in the lamps themselves. Hence by measuring the voltage from B to the ground and dividing by voltage of each lamp, the number of lamps between station and ground can be determined, at any time when the lights are burning. To check, measure voltage from A to ground.

Another fairly simple method is to pass direct current through the grounded wire, instead of alternating current as previously described. Then have the lineman pass along the line with an ordinary pocket compass. If held underneath a wire in which current is flowing, the needle will try to assume a position at right angles to the line. To overcome the earth's magnetism hold a nail near the magnet. As long then as we are between the source of power and the ground, the needle will deflect, but on branch lines or beyond the ground there will be no variation of the compass.

Many companies burn their grounds out. This may result in the destruction of the line; but as a ground has seldom as great conductivity as the line wire itself, it will generally go first. A patient, systematic search will, however, locate the trouble, starting at the power house, locating the line, then the approximate part of line as described above, and finally narrowing down to a careful examination of line work in the probable locality of the fault.

MOTORS IN SERIES

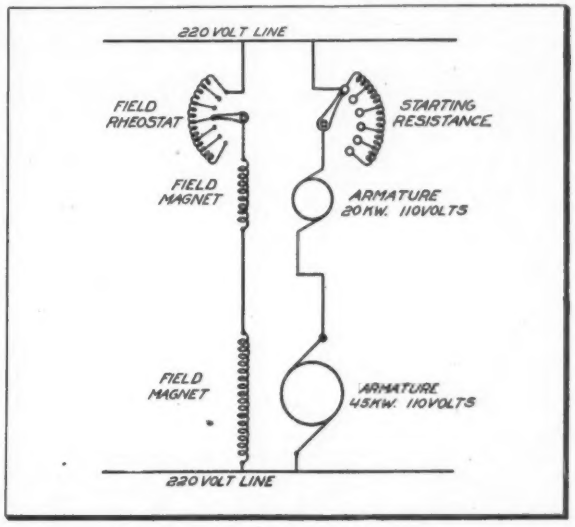
REFERRING to the answer signed A. L. R. to the letter of J. J. H., page 274 of the issue of Feb. 15, 1913. We find 2 110-volt, shunt wound, motors, 45 and 20 kw. respectively, connected across 220 volts in 2 series circuits, fields in one circuit and armatures in the other.

Assume the resistance of the motors are inversely proportional to their rated capacity; that is, the larger is 20/45 of the smaller, a near enough approximation for studying this answer; both fields being in series the drop in each is proportional to the resistance, about 152 and 68 volts with resistance all out as it should be. The effect of the rheostat is to change the amount of excitation but the relative drops are in the same proportion. That is the fields of the smaller are over excited, and the larger has an insufficient field current.

If each armature were now to have an impressed e.m.f. of 110 volts, the speed of the 20-kw. would be below normal and the 45-kw. would run above normal, the speeds depending on the saturation curve.

But instead of there being 110 volts on each armature, the 2 are connected in series on 220 volts. The drop is divided between them in proportion to the counter e.m.f.'s plus the CR drop in each. With equal loads the CR drop is less and the counter e.m.f. is higher in the larger. Since the machines are in series the current is the same in each. The larger having the higher counter e.m.f., speeds up as it has the greater power. Watts = current × e.m.f., and the smaller will slow down decreasing its counter e.m.f. in the endeavor to draw more current from line. The equilibrium is unstable until the smaller comes to a standstill. The speed of the larger will then correspond to a weakened field due to 68 volts and an armature impressed e.m.f. of 220 volts, less the resistance drop in the smaller. These are runaway conditions and the chances are that the commutator will burst.

This is on the assumption of equal loads on both machines. But as mathematically equal loads are an impossibility, the same reasoning applies to unequal loads which will be the case in actual practice.



MOTOR CONNECTIONS QUESTIONED

The heavier loaded machine slows down to draw more current from line while the lighter loaded speeds up to decrease current. Our speeds are unstable until the heavier loaded armature reaches a standstill and the other races.

As to the final statement that you can't transform for 220 to 110 volts, while strictly correct, it is nevertheless true that you can balance your 2 sides with a coil by the well known method of Michael von Dolivo Dolbrowolsky. It is merely necessary to add collector rings to the d.c. armature, connecting their brushes to a balance coil, really a single coil, or auto transformer. The center of this gives a neutral point for the 110-220 volt 3-wire system. In practice 4 rings and a 2-phase system is used. Irving Booth.

AN ITALIAN INVENTION for depositing metals by the electro-plating process is announced. By its use a film of any kind of metal can be deposited on any insoluble surface, so that not only silver and nickel, but zinc, tin or lead can be deposited and on any kind of a surface, such as china, wood or glass. The only condition is that the surface to be plated must be rough, and in the case of a glazed article, the surface must be roughened by a sand blast, so as to give the metal a hold. The plating may be sufficiently thick to admit of engraving, and forms a coating which adheres firmly to the surface and cannot be peeled off.

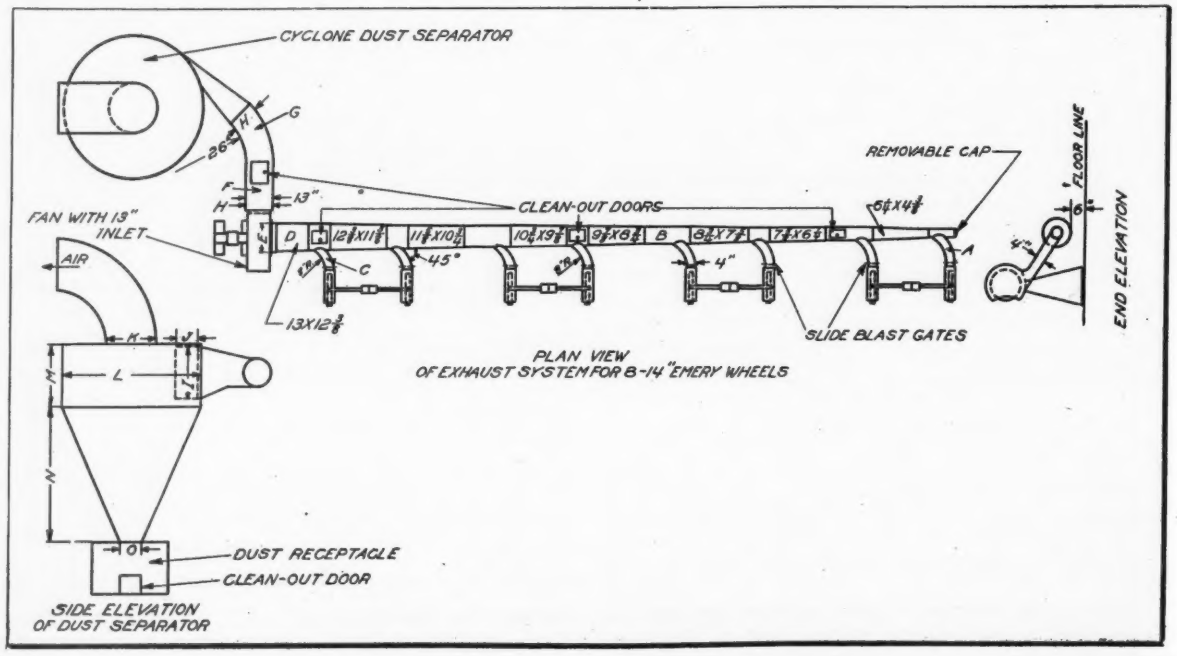
IT IS MORE MEN that the world wants, not more systems. It is character that our modern life waits for, to redeem and transform it; and conduct is the fruitage of character.

EXHAUST SYSTEMS FOR GRINDING AND BUFFING WHEELS

Specifications Prepared by Wm. Newell, of the Department of Labor of New York State, Giving Sizes of Pipe and Proper Methods for Installation

FREEDOM from dust in a room where employes are working is productive of high efficiency of both men and machinery, and to secure such freedom in a plant where grinding and polishing operations are carried on, requires the installation of a satisfactory exhausting system to remove this dust. Such a system, unless properly proportioned and installed, may be entirely inadequate, and a large expense may be incurred for a plant which is practically useless.

To avoid this, the specifications and information herewith have been prepared, certain parts being compulsory in the State of New York, and other parts being recommendations which will help toward efficiency and satisfactory operation.



ARRANGEMENT OF EMERY WHEEL EXHAUSTER SYSTEM

General Arrangement

IN the general layout, it is recommended that emery wheel and buffing wheel systems be kept separate, because sparks from the emery wheels may set fire to the lint and dust from the buffing wheels if both are carried through the same suction main.

In those wheels which have the top running toward the operator, the main suction duct should be back of and below the wheels, not less than 6 in. above the floor, to avoid possible charring in case of fire in main duct, and also to permit sweeping under it. This location is recommended so that all dust will settle into the main.

Main suction and discharge pipes should be made short and with as few bends as possible, to cut down the friction loss, and where there must be considerable distance from the wheels to the cyclone, it is best to keep the fan near the last branch which enters the main, making the discharge end the long one.

Pockets or low places where dust may accumulate should be avoided, if possible, and if this cannot be done, a trap should be installed and kept cleaned out.

Branches and Mains

BRANCH pipes must enter the main suction duct at an angle not exceeding 45 deg., and must incline in the direction of the air flow at the junction with the main, as shown in the illustration herewith. The ends of branch pipes must not project into the main duct, and the duct must be made so that all laps in piping point in the direction of air flow.

For bends, turns or elbows in main or branch pipes, the radius in the throat must be at least 1.5 times the diameter of the pipe, and should preferably have the radius twice the diameter of the pipe wherever space permits. These branches must enter the main on the top or sides, never at the bottom, and 2 branches should never enter a main exactly opposite one another.

The main suction should be enlarged between every 2 branch pipes entering it, if possible, and in no case should more than 2 branches enter the main duct in a section of uniform area. All enlargements in the main must be made on a taper, not by abrupt change.

Each branch pipe should have a shut-off damper which may be closed when the wheel is not in use; but not more than one-fourth of these gates should be

closed at any one time, as the air velocity in the main duct might drop so low as to let dust accumulate on the bottom.

Elbows should be made of metal, one or two gages heavier than the main pipe, because the wear is greater on them.

Hoods

IN forming the hood for the wheel, it should go far enough forward beneath the front to insure that all dust will enter it, even though considerable space must be left between the wheel and the lower part of the hood in order not to interfere with the work. The branch pipe should lead from the hood as nearly as possible at the point where dust will naturally be thrown by the wheels, and no screen should ever be used across the mouth of the branch pipe, as this will obstruct the passage of material and may, in a short time, be almost stopped up.

A trap at the junction of hood and branch pipe is desirable to collect the heavier particles of dust, thus taking some wear off the fan, and also to catch nuts or small articles dropped by accident into the hood.

Sizes of Pipes

THE minimum sizes of branch pipes allowed for different sizes emery or other grinding wheels are shown in the Data Tables, and also sizes of branch pipes for buffing or polishing wheels. In case of a wheel thicker than given in the table, it must have a branch pipe at least as large as called for by its grinding surface.

These branch pipes must have sizes not less than specified in the table, throughout their entire length, and the area of the main must be so chosen that it shall be at least 20 per cent greater than the combined areas of branch pipes entering it between any given point and the dead end of the system.

The inlet of fan or exhauster shall be at least 20 per cent greater in area than the sum of the areas of all branch pipes. The Data Tables give the size of the main suction duct at any point, for any number of uniform size branch pipes with 20 per cent excess of area.

The discharge pipe from the fan shall be as large or larger than the fan inlet throughout its entire length. Main trunk lines for both suction and discharge shall have suitable clean-out doors not over 10 ft. apart, and the dead end of the suction main shall have a removable cap on it. A draft head of 2 in. of water shall be maintained in each branch pipe within one foot of the hood, this draft being tested by a U-tube water gage with rubber connection.

The Cyclone

MR. Newell states that recommendations for the cyclone separator, or dust collector, are difficult, as the separator must be proportioned to suit operating conditions. Light dusts require a larger separator than the heavy dusts. The Data Tables give dimensions of one prominent manufacturer, such as are suitable for metallic dusts and wood shavings. For these the inlet area of the cyclone should be as large as the area of the discharge pipe from the fan. For light buffing dusts the air outlet from the cyclone should be large enough so that the discharge velocity will not exceed 480 ft. a minute, and 300 ft. is better. Other dimensions of the separator should then be made proportionately. The air outlet should have a proper elbow to exclude the weather, but be otherwise unobstructed. The cyclone should be set so that there is ample clearance beneath it and dust should never be allowed to pile up as high as the bottom of the separator.

The illustration herewith shows a sample system for 8 14-in. emery wheels with dimensions.

INSTRUCTIONS FOR DIESEL ENGINEERS

By John Pierce

IT is not my purpose to depreciate the erecting engineer, nor to establish a record as an authority, in the following, yet I know there must be others who have experienced the same feelings that I have when first starting in to operate a Diesel oil engine, The printed instruction for this engine are very few, and contain but little of benefit to the inexperienced Diesel engineer, and there seems to be no literature on this particular engine. I know how eagerly I watched my magazines, and do yet, for something of practical benefit to the operator rather than for technical oil engine lectures.

The erecting man is with us such a short time, and though he is willing to answer any and all questions, yet we do not, as beginners, know what to ask. Of course nothing ever happens as long as he is there. I am going to give the rest of the boys the benefit of the things which I have learned, and not do like a certain operator I ran across, in Texas, who would always slip back at night and do his repair work, so that no one else might learn. Perhaps my article may benefit somebody. I know that it is practical, in any case, for I am putting the following points to use every day. Of course there are a great many little things, which I shall not go into for anyone can see them, readily, while operating the engine and can overcome them. I intend to take up merely the few points not covered by the printed matter (at least so that the average man can understand it) and not thought of by the erecting engineer. The cams are all keyed to the cam shaft, so we will first set the shaft.

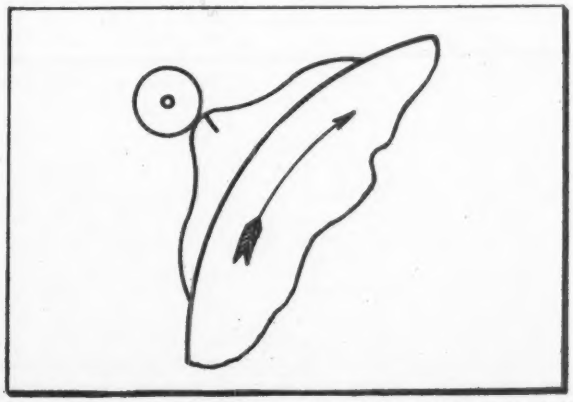


FIG. 1. RELATIVE POSITION OF CAM ROLLER AND FUEL CAM AT DEAD CENTER

Place No. 2 crank on the dead firing center, and place the mark, found on the side of the fuel nose of No. 2, 1/32 in. ahead of the cam roller; not the center of the roller, but ahead of the circumference as shown in Fig.

1. For this purpose it is better to keep a new roller always on hand, which can be replaced by the old one after the shaft is set; for this roller, being used for this purpose, must be full size and perfect. When this has been done, being very careful that the spring tension, on the fuel rod, does not cause the cam shaft to turn, the intermediate gear wheel is slipped into place and secured. Of course this can be done by using either No. 1 or No. 3, as well as No. 2, only No. 2 is the most convenient to get at, as it is almost impossible to get at the others for this adjustment.

To Set the Pump Governor

FIRST raise the governor to its highest position, and then turn the pump eccentric shaft with the crank, until eccentric No. 1 is in its highest position. Then, slip an ordinary shipping tag between the roller on the

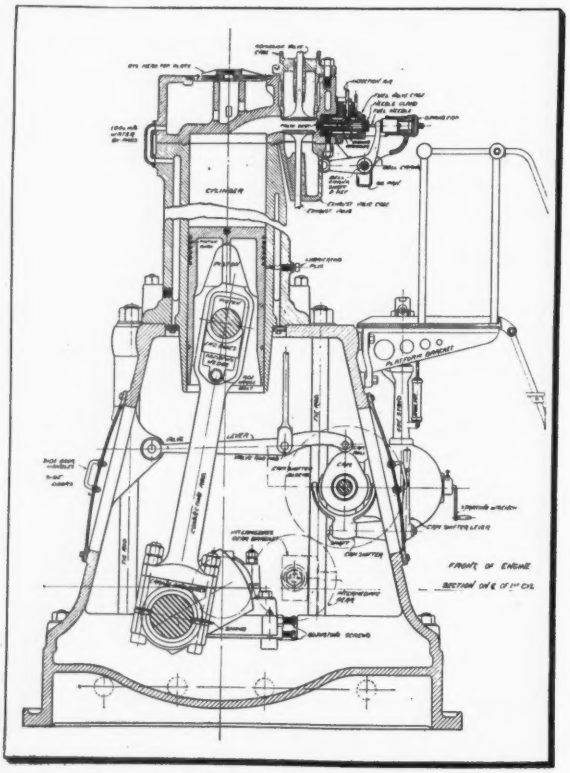


FIG. 2. SECTION OF DIESEL ENGINE SHOWING ARRANGEMENT OF PARTS

suction valve arm, and the top of the suction valve stem. If it is not a snug fit, the rod should be shortened, or lengthened (as the case may be) until a snug fit is secured. Care must be taken to see that the spring raises the suction valve to its extreme length before making the measurement.

No. 1 having been adjusted, No. 2 and No. 3 are to be treated in the same manner. The erecting engineer, who came with the engine which I am operating, set the working stroke of the pump so that it had reached its maximum pressure and was backing away on its suction stroke when the fuel needle opened, and the engine took fuel. But I have found, by careful experiments, that an engine maintains its closed regulation by turning it until either of the fuel noses is just on its proper position to touch its respective fuel rod roller, and so set the pump that the pump has completed ⅔ of its delivery stroke to that respective cylinder. Then the maximum pressure is being applied at the instant the needle opens. With the erecting engineer's adjustment this point was passed when the needle opened, and the fuel fed to the cylinder was to a certain extent wiredrawn, or pressureless, causing a decided drop in speed under peak load.

In order to set the pump, one must take the cover off the gear side and remove the main gear and spring. Turn the engine until No. 1, No. 2, or No. 3 fuel nose is just touching its respective roller. Then turn the pump ecccentric until the stroke of that pump has completed ⅔ of its delivery stroke, hold it in this position and insert the gear wheel, being careful that the clutch dogs will come exactly together; replace the spring and cover and the pump is properly adjusted.

To Pack the Needle Valve

IT is better, according to my experience, to get cut rings, for the needles, directly from the engine makers, as it is to their interest to supply the best for this purpose. At first I thought differently, and so sent to a high grade packing concern, who assured me that they made the best packing for this purpose; I used their material, to my sorrow, for it contained white lead, which, freed by the action of the fuel, went into, or rather between, the atomizer and the needle, causing the needle to stick in the atomizer, and pulled the atomizer off its dowel pin, and let all my air get away, shutting down the engine. I had to dismantle the entire cage, take the nozzle off and saw the needle in two, in order to get the atomizer out, having to take it out the front end. Since then I've used a different make, but with poor success. So I sent to the builders, direct, and have since had no trouble from that source.

The proper way to pack the needle, according to the printed instructions of the builders, is to soak the packing in oil and graphite for a week, prior to using it, but this is not a good plan. It is better to pack with dry packing, then slip the needle out, and with a rag on the end of a wire, swab out the inside of the rings thoroughly with a mixture of half cylinder oil and half graphite. Do this once a week, loosening the gland slightly, but not enough to allow the atomizer to get out of place when the needle is withdrawn. This will, in a short time, give both the needle and the packing a highly polished surface, which will stay tight. This is the only method whereby one can run with a dry needle, and avoid drippings.

The Air Admission Valve

IT is better to have on hand a complete admission valve, for these valves have a large area and leak very readily. Therefore, it is better to have the extra one complete, and each week take off, first say No. 1, and put on the extra one. During the week the one taken off can be ground in and got in shape for use. The next week take off No. 2, and the third week No. 3. This gives a new-ground valve every 3 weeks. The exhaust valve will give but little trouble, except breaking a spring frequently; but as these cost practically nothing, one should keep a large supply of them on hand.

To set the air admission valve, turn the engine until the air valve cam is at its lowest part, then with a bar pry up the roller arm. There should be 1/16 in. clearance between the roller and the cam when the lever, inside the cage, makes contact with the fiber disk.

To set the exhaust valve, the engine is turned until the exhaust cam gets to its lowest point, and then there should be 1/16 in. clearance between the nuts at the bottom of the valve stem and the top of the cam rod. Adjustment is made by moving the nuts on the valve stem itself and not on the cam rod. The fuel rod should be adjusted while the engine is running, and there should just be daylight between the fiber disk and the needle lever when the rod is down. Fuel noses should be examined once a week to see that they do not work loose. A drop of heavy oil should be put in the dashpot once each 24 hr. I have found that by taking off the ⅛-in. fittings on the dashpot and tapping for and using ¼-in. I get a quieter working pot.

Packing the Oil Pump

THE beginner will find that unless he is lucky enough to get the right way, packing the delivery side of the oil pump is a hard proposition.

The proper way to do this is to take out the 2 screws in the pin holding the plunger to the eccentric and turn the eccentric shaft until the one being packed is at the bottom of its travel. Then take out the plunger itself, and the packing is easily removed. Then replace the plunger and pack. Insert the gland and place 2 equal sized pieces of metal, one on either side of the plunger, push the gland nut up against them, and turn the eccentric, forcing the packing up into the stuffing box. One will be able to get in considerable more packing this way. Set this packing up tight. The suction side should be packed lightly, using a packing free from rubber, or white lead.

The Atomizer

UNTIL the pipes are perfectly free of foreign matter the atomizer should be examined once a month, but after 3 months it need not be touched more than once every 4 months. The strainer in oil lines should be cleaned at least once a week, thus insuring clean oil, and plenty of it.

Crank Case Oil

THE amount of oil and water used in the crank case must be governed by circumstances. In some engines more water is evaporated than in others. I find, by taking a little oil on a stick and going to the light, that the oil shows a greenish cast as long as it is good, but when it shows a dead black it is full of carbon and dirt, and the crank case must be cleaned. Clean the case and bearings thoroughly, and put in new oil. The builders advise a certain amount daily, but in my case I use ½ gal. per crank each 24 hr., also 18 gal. of water. One very particular thing to remember in starting and stopping is to shut off the water going over the needle before stopping, and not starting the water until the engine has been started, for if the drains should be a little clogged, the water will back up through the exhaust and into the cylinder.

The jacket water should be kept on for 15 min. after stopping. One should have a set of high-pressure fittings and a hand oil pump, with plug cock between it and cylinder, on each of the cylinders, so that as soon as the engine is stopped a pint of kerosene can be forced into the rings, and cut loose any carbon formed there. These pumps can be attached by using the indicator taps. While doing this be certain that air admission release levers are up, so that the vapor and gas can escape.

For safety's sake, as well as convenience, my circulating pump has an alarm gage attached, so in case the water supply is stopped I am instantly warned. Also, I have extension tube thermometers on my water outlets, with alarm connections, so that I may know from a distance of any heating. The admission valve cage screen should be wrapped with cheese cloth, and this changed once a week, being careful when changing, that no dirt gets into the dashpot, or valve. Before starting it is well to take a bar and test needles, to see that they are not sticking.

The Compressor

TO the prospective buyer I would say, get a coupling (flexible), and direct connect to the engine shaft; it is the only perfect way. We have tried motor, belt, and direct connection. In the union in the intermediate air line just before it enters the high-pressure cylinder, insert a fine woven brass wire screen. This will save lots of grief in the way of dirt getting in the high-pressure valve, causing numerous shut-downs, and scoring the valve.

The erecting engineer will tell you to use the unloaders according to your load, but I have found it better to keep them both closed and bleed my high-pressure line at the cock invariably placed below the

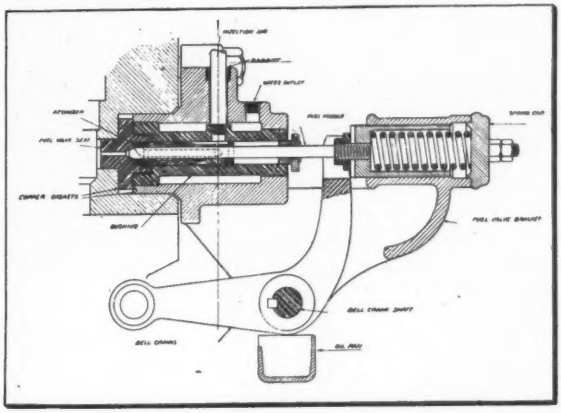


FIG. 3. SECTION OF FUEL NEEDLE VALVE, ATOMIZER AND STUFFING BOX

check valve at the base of the bottles, and keep my air as I want it by regulating this cock. This also serves to blow out the condensation, gummy oil, and dirt that would otherwise be carried into the bottles. I simply attach a small hose to this cock, and blow the stuff outside.

If possible keep your air lines above the floor, even if you have to carry them overhead. And above all things be clean in every way as regards the machines, for dirt is the greatest enemy the Diesel engine has to contend with.

YOU ARE WAITING to do some great thing—you are all waiting to pull down some great evil. Perform the small things that are unseen, and they will bring other and greater things for you to perform. You would bleed and die for your country. Citizenship does not demand any such act of heroism. Do the small things, and the first one that comes to you, and a second will immediately come. —John Bright.

ONE OF THE SPECIAL needs of our day is more time for meditation and reflection.

—Canon MacColl.

FOR UNCLE SAM'S BOYS

(Continued from page 489)

and 12-in. stroke, and are outside packed plunger type. A 3-in. injector is also provided for emergency use.

The vacuum pumps handle all the condensation from the steam lines to the buildings, and are of Marsh long-yoke, low-down type, with 10-in. steam cylinders, 14-in. water cylinders and 20-in. stroke, having a capacity of 13.3 gal. a stroke, or about 65,000 lb. of water an hour. The cold water pumped is meas-

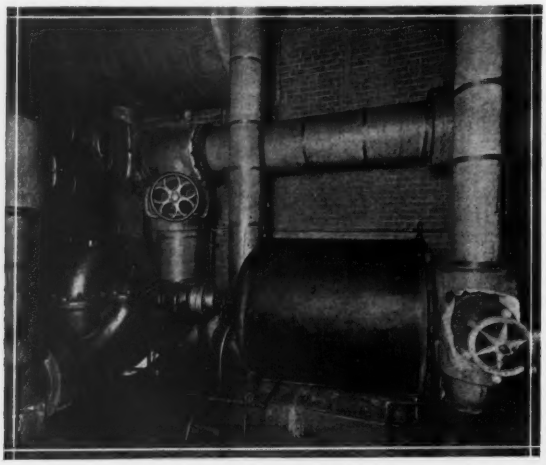


FIG. 9. TURBINE DRIVING CIRCULATING PUMP FOR HOT WATER HEATING

ured by a 12-in. Worthington meter. Originally it was intended to use counters on the boiler feed pumps to measure the feed water, but this did not prove satisfactory, so that no means is at present provided for such measurement. Tagliabue thermometers are provided for keeping track of the temperature of outgoing and returning water from the heating system, for meas-

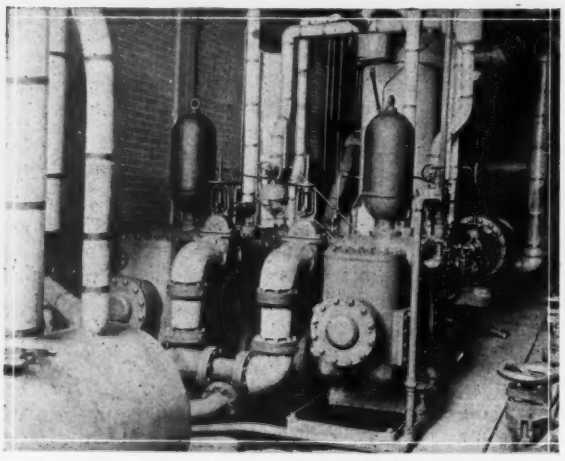


FIG. 10. BOILER FEED PUMPS AND FEED HEATER

uring feed-water temperature and for the refrigerating apparatus. On the gage board in the engine room is an equipment of Ashcroft gages, for showing steam pressure, the pressure in the exhaust heater, the pressure in the supply mains to the grounds, vacuum on the return, pressure in the hot water circulation system, and gages for the Venturi meter, for reading the amount of hot water circulating. Other gages are provided in boiler and pump and refrigerating rooms, as necessary for the proper operation of the machinery.

Water Supply

WATER is taken from the intake in the lake and sent to the filter plant, where it passes through about 12 ft. of fine sand, into a settling chamber. From this it is taken by the service pump and forced into the supply mains for the entire Training Station. The water is pumped to the filtration plant by 2 2-in. horizontal D'Olier centrifugal pumps, driven by 2-hp. Western Electric induction motors, and from the filter reservoir the water is taken by an American compound reciprocating pump, 10 and 16 by 10 in., and 16-in. stroke, having a capacity of 400 gal. a minute at a piston speed of 100 ft. a minute, against 115 lb. head, with steam at 100 lb. and the back pressure 5 lb. The guarantee on this pump called for not over 45 lb. of steam a horsepower-hour, or 45,000,000 foot pounds duty per thousand pounds of dry steam. This unit is not duplicated as there are available 2 standard

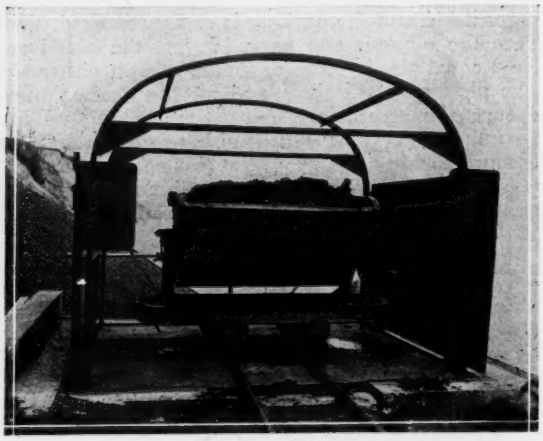


FIG. 11. ASH HOIST DISCHARGING CAR

Underwriters fire pumps, each 16 by 9 by 12, with a capacity of 750 gal. a minute for use in case of emergency. These fire pumps may draw either from storage basin of the water filtration plant or from the lake intake well, or in case of obstruction from anchor ice at the intake crib, they may be used to pump water back to the crib and thus flush out the pipe and crib screens.

Refrigerating Plant

AS already mentioned, this is installed in the freezing room in the basement of the power house and serves to operate the 5-ton ice-making plant, and also to cool the brine which is pumped through one-half mile of brine line to the refrigerating rooms and cold storage in the basement of the Mess Hall. This brine line is of 3-in. insulated pipe laid underground, and provided with expansion joints. The ammonia compressor is made by the York Mfg. Co., a vertical, single-acting machine, with cylinder 11½ in. diameter by 16-in. stroke, and steam cylinder 15 in. diameter by 15-in. stroke, giving a ton of refrigeration for 1.7 hp., and using 30 lb. of steam per horsepower-hour at full load, with steam at 130 lb. pressure.

The ammonia condenser consists of 2 York double-pipe stands, of 1¼ and 2-in. pipe, 14 pipes high and 19 ft. long, and delivering the condensed ammonia

to a York receiver 20 in. in diameter and 7 ft. long, placed beneath the condenser. From the compressor, ammonia is supplied to the freezing tank and to a brine cooler. The freezing tank is of ¼-in. steel 23 ft. long, 14 ft. 4 in. wide and 38 in. high, having 2130 ft. of 1¼-in. ammonia direct expansion pipe, and capacity for 99 200-lb. cans. In the tank is a brine circulator, driven by a Westinghouse direct-connected vertical motor.

Insulation for the tank consists for the floor, of 2 layers of 3-in. Nonpareil cork boards, set in asphalt, with 8 in. of granulated cork all around the sides. For handling the ice cans, a hand crane is installed above the ice tank, and at the end is an ice dump and automatic thawing apparatus, with a chute to the ice storage room. The usual auxiliary apparatus, grease extractor, reboiler and skimmer, cooling coil, water filters, can filter and storage tank are provided. In the brine cooler for the circulating system, there are 2 stands of York counter-current double-pipe type, consisting of 2-in. and 3-in. pipe, 8 pipes high and 18 ft. long, set in an insulated compartment. The brine tank on the roof is 46 in. diameter by 4 ft. high, and brine is circulated through the system by a centrifugal pump, having a capacity of 4000 gal. an hour, and driven by a 3-phase induction motor.

The temperature difference between incoming and outgoing brine is regulated according to the needs of the season, and at the time of inspection the temperature was 5 deg. F. for the outgoing, and 15 deg. F. for the return. A brine meter is installed on the 3-in. circulating pipe which runs to the Mess Hall.

Expansion joints are placed about 800 ft. apart and the entire transmission line is covered with Nonpareil sectional compressed cork covering, 2½ in. thick with mineral rubber finish and fastened with copper wire.

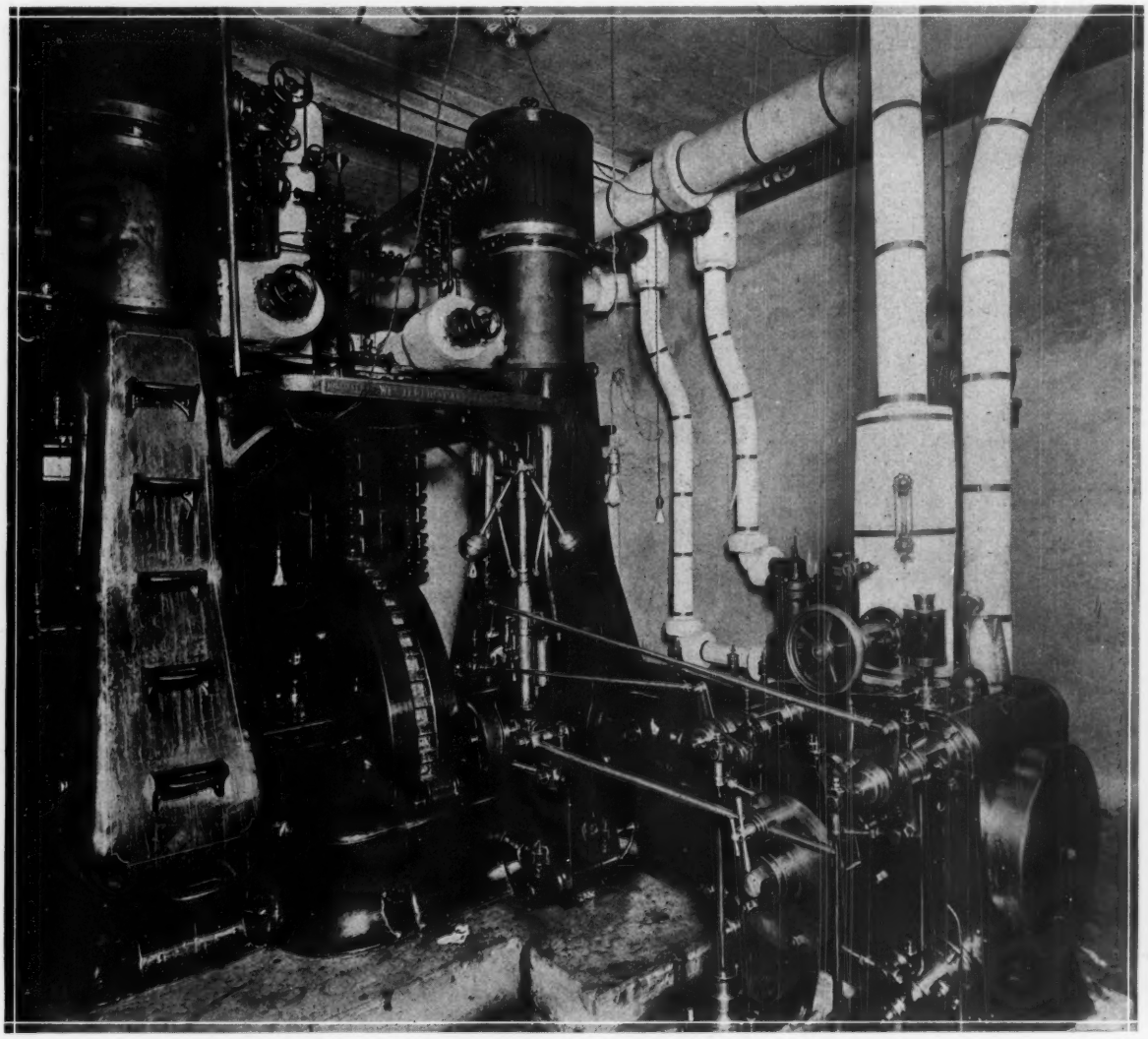


FIG. 12. AMMONIA COMPRESSOR IN FREEZING ROOM

Following are data in regard to the cold storage rooms in the basement of the Mess Hall, which may be found of interest in constructing similar plants. One freezer room, 9 ft. 6 in. by 24 ft. by 9 ft. 3 in. is maintained at a temperature of 10 deg. by 650 linear feet of 1¼-in. pipe. One beef storage room 24 ft. 3 in., by 30 ft. 5 in., by 9 ft. 3 in., is kept at 28 to 34 deg. by 900 ft. of pipe. One cooler, 17 ft. by 24 ft. by 10 ft. 8 in. is kept at 34 to 40 deg. by 460 ft. of pipe. One cooler 16 ft. 6 in., by 13 ft. 3 in., by 10 ft. 8 in.

is kept at 34 to 40 deg. by 290 ft. of pipe. One cooler 18 ft. by 13 ft. 3 in., by 10 ft. 8 in., is kept at 34 to 40 deg. by 280 ft. of pipe. Test of the installation showed that the freezing room could be run to below zero and the other rooms held at the required temperatures with the piping as installed. Insulation of the storage rooms was in general Nonpareil compressed cork, 6 inches thick on the outside walls, 4 in. thick on the outside walls of the cooling room and 2 in. thick between the cooling rooms and corridors. For floors and ceilings the thickness was made 4 in. The walls and ceiling insulation was laid in 2 layers, in ½-in. mortar and finished with a ½ in. of cement plaster. Ceilings of freezing and beef rooms were furred down and on other rooms the insulation was laid against reinforced concrete floors; on the walls it was laid on 4-in. hollow tile partitions. Floor insulation was laid in hot asphalt with 1½-in. asphalt floor finish.

FIG. 14. INTERIOR OF FILTERING PLANT

Heating System

IN deciding on the heating system to be adopted, comparison was made between steam and hot water. Five pounds was placed as the limit of back pressure for steam, and it was found that a 24-in. pipe would be needed from the power house for this purpose, while for high pressure steam a 7-in. main would be sufficient. The low pressure steam would not carry throughout the entire grounds at the pressure desired. This, and the fact that the temperature of hot water radiators could be varied at the power house according to the weather, decided in favor of the hot water heating, and it was found also that a saving in steam would be effected by the central control of the heat, which, altogether, would amount to $10,000 a year lower cost for the hot water system than could be secured by steam. As it was necessary to have live steam in certain of the buildings for heating hot water, cooking, laundry work, etc., it was determined to put all indirect heating coils on the steam system and to have a certain amount of steam heat in dormitories and other buildings in case the hot water system should be under repair at any time.

Hot Water Mains

ARRANGEMENT of these mains follows closely the Evans-Almirall system, the water being forced through the distributing main with single pipe branches running around the basement of the individual buildings from which the radiators draw hot water by gravity. Each radiator, or group of radiators has a separate supply and return to the one pipe main, thus, giving an elastic system. As the water in a radiator cools it is automatically dropped to the main and hot water rises to take its place, and as long as hot

water is circulated in the main, the radiators feed themselves. This method also permits the arrangement of piping to each radiator so that it will be sure to get the necessary supply of water regardless of the pressure on the circulation system, and by means of bypass connections, it permits of starting up the system in cold weather and filling and warming the main distribution pipe and then turning on one building at a time, as may be necessary. In so long a system as this, the matter above mentioned is of importance, as, if all buildings were on when the mains were started up the pipes in the buildings might freeze before the water could be warmed.

Another advantage is that the circulating mains are so large that they give a good reservoir of heat and it is possible to shut down the plant for some hours for repairs to expansion joints without trouble from cooling of the buildings.

Pumps in the power house and the 14-in. hot water piping are large enough to care for a future expansion to the size mentioned at the beginning of the article. The volume of heat supplied to the buildings can be varied not only by raising the temperature of the water, but also by increasing the speed of the circulating pump and, therefore, the quantity of water circulated. Should occasion require, the water could be sent out at 210 deg. or above.

Complete circulation of water through the mains takes from 15 to 40 minutes according to the route taken. Mains and branches were all figured to give a velocity of from 3.6 to 6.5 ft. a second, and in the case of the loop around officers' quarters, a separate pipe was run with separate return to the power house in order to force circulation around the buildings. In the tower of the administration building, an expansion tank 10 by 11 by 5½ ft. is located and connected to the

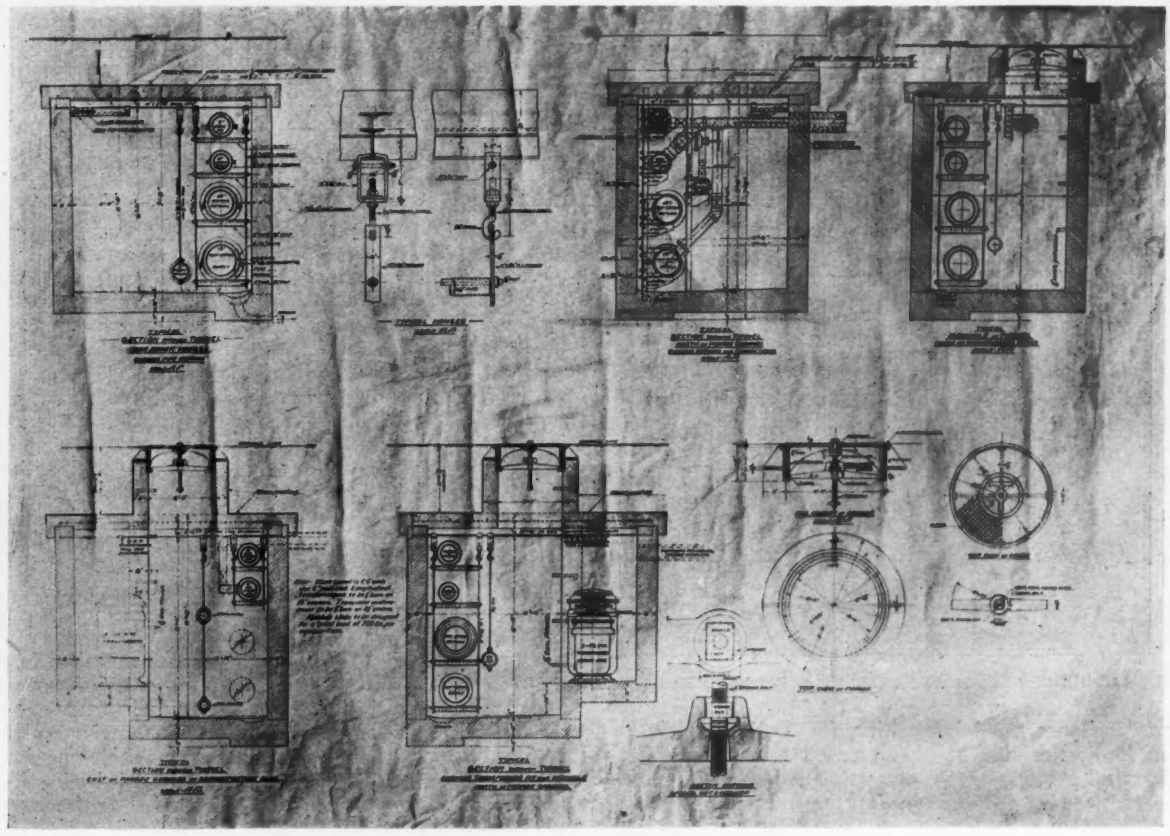


FIG. 15. SECTIONS AND DETAILS OF TUNNEL CONSTRUCTION

Scale pockets with blow-out valves are placed at all points where mains rise and automatic air valves at all high points to remove any air collecting from the water. Air cocks are placed at the ends of the mains to permit of rapid filling; hot water thermometers are at each building entrance, and connections for pressure gage and hot water thermometer at each building's branch return to the main.

To prevent short circuiting of the water through buildings nearest the power house, a point about the center of service of the main buildings was selected for equal pressure, and all mains, both the supply and return, were run to this point and water brought back to the power house in a common return.

return mains near the power house. The quantity of water circulated is based on a drop of 30 deg. temperature between the outgoing and returning water when the temperature outdoors is 10 deg. below zero.

Expansion joints of slip pattern were placed at about 350 ft. centers. The underground pipe was covered with insulation made by the Philip Carey Co., consisting of 1 in. of alternate layers of wool felt and asbestos, over which is ¼ in. of compressed roofing and insulating compound, all covered by 7-oz. canvas and brass bands, and painted 2 coats. The roofing and insulating compound render the covering waterproof and protect the wool felt from dampness and moisture in the tunnel. The covering is also hard so that it is

not necessary to cut through where the pipe rests on rollers in hangers. A cast plate of less than half the circumference of the covering and about 8 in. long is set under the covering to give a broad bearing and this plate, held in place by small rod straps across the top of the covering, rests on the roller bearings.

Steam Distribution

ALL the distributing mains for steam which run parallel to the hot water mains are on high pressure. Service in the buildings is on low pressure of 5 to 20 lb., except in the mess hall and laundry, and all returns from the system are handled through vacuum lines. Condensation from the high-pressure mains and apparatus is carried to receivers with trap discharge into the low-pressure system, any portion of the high pressure condensation which would turn into steam at 20 pounds or less being passed into low pressure apparatus and drained to thermofiers which feed the vacuum returns.

A total of 15,190 sq. ft. of indirect steam radiation is used in various buildings as described in the general paragraph on the heating loads. Mains leaving the

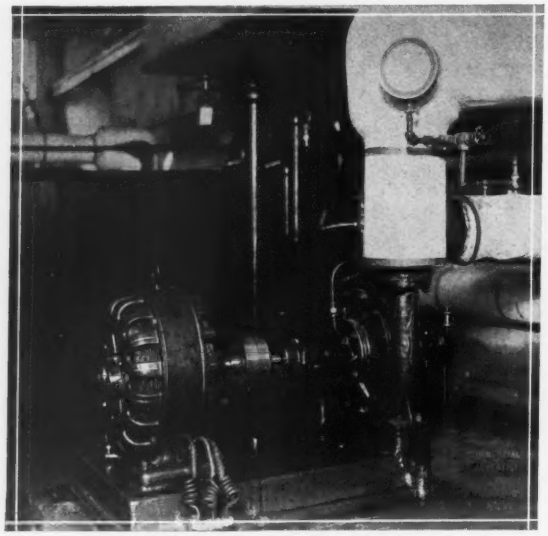


FIG. 13. BRINE CIRCULATING PUMP DELIVERING TO MESS HALL

power house are 7-in., calling for 55,000 lb. of steam an hour, the size being increased to 9 in. when the hospital group of buildings was added. The pipe line is reduced as various buildings are tapped off, 29,000 lb. an hour being carried as far as the 2 north dormitories, 16,000 lb., to the 2 south dormitories, and 2500 lb. an hour to the receiving group. The 6-in. line was carried to the 2 north dormitories, 5 in. to the 2 south dormitories, and 3-in. to the receiving group.

Vacuum Returns

FROM the best data available, and by careful estimate, it was decided that the pipe lines for the vacuum returns would be about 1 in. in diameter smaller than the steam mains except for sizes 2 in. and under. All tests made show that these sizes are satisfactory. The vacuum mains in tunnel, conduits and buildings are left uncovered to prevent condensation discharge being converted to steam under vacuum.

As the far end of the vacuum line on the receiving plateau is nearly 8 ft. below the elevation where the vacuum main passes over the bluff at the power house, it is necessary to lift all condensation about 8 ft. This is accomplished at 2 points by the use of a special fitting like a trapped 45 deg. elbow, the condensation flowing and accumulating in this trapped fitting until it rises to a certain height, when it is drawn over the 45-deg. 4-ft. rise in slugs, and then flows by gravity as well as by suction pull to the next trapped fitting or to the drop at the power house.

Electrical Distribution

ALL connections on the system are in delta and the 3 wires of the 3-phase circuit are carried clear through to the panel board in every instance, even in the lighting of the officers' quarters. There are 3 arc circuits, one for each phase, with 12 to 14 lamps on each leg. All mains are carried in the tunnel and conduits, and are lead sheathed with paper insulation, carrying 3 and 2-wire cable, as required. Lamps are 110-volt; motors are 220-volt 3-phase. Transformers of the subway type, about 75 in number, were installed single phase, located in tunnels and manholes, outside of the buildings, so that no primaries were carried into the buildings except the power house.

Tunnels and Distribution Conduit

FROM the power house to the northeast intersection of the parade ground the main tunnel is 6 ft. by 6 ft. 3 in.; along the north side and west end of the parade ground it is 4 ft. 6 in. wide by 6 ft. 3 in. high, and along the east side of the parade ground 4 ft. wide by 6 ft. 3 in. high. Floor and walls are of 8 in. of concrete, in proportions 1-2½-2/5, not reinforced. The roof is 7 in. and 6 in. thick, of concrete in proportions 1-2-4, and reinforced longitudinally for shrinkage and across for a load of 750 lb. per sq. ft. except under road crossings where it is reinforced for a 15-ton road roller. The top is graded to shed water and is water-proofed with 2 coats of Cunningham coal-tar paint. Sides are not water-proofed and the floor has a gutter and is drained at low points to the drainage system. The pitch of vacuum returns determined the elevation of tunnel and conduits, and pipes are hung from 4-in. I beams projecting 3 in. below the ceiling of the tunnel. The hangers are adjustable and pipes fit one above another along the side, resting on pipe rollers. Where expansion joints and anchors are used they are secured to stiff angle frames running from floor to roof. Adjustable manhole covers with special ventilation were designed for the tunnel.

Electric cables were supported by racks on the ceiling beams with transformers and manhole openings set in an alcove of the tunnel on a lead raised a foot above the floor and with shells grounded to the water pipe. Outside of the tunnel the electric mains are carried in vitrified conduits with 3 in. of concrete on sides and top.

For all branches of the heating mains, concrete slab conduits are built with floor 4 in. thick laid in place, and sides and roof of molded slabs as long as could be conveniently handled. The roof slabs were reinforced to carry 750 lb. per sq. ft. Pipes rest on rollers running in cast shoes on the floor, and are covered and painted as in the tunnel. These conduits are drained to manholes which drain to the drainage system and connections to the heating system are made at fixed parts of the expansion joint and at anchors located in manholes about 300 ft. apart. For a 36-in. wide conduit, the sides were 3 in. thick and the roof 4 in. thick.

For steam supply to the hospital, a 6-in. main was run, supplying heat to the basement for hot water

radiation and for indirect fan coils, disinfecting plant, etc. Hot water for the 3 medical officers' quarters is also supplied from this heater by an electrically driven centrifugal pump, and condensation is pumped back to the laundry building, heating it on the way to the power house. Vacuum return could not be used from the hospital plateau, on account of the drop in the elevation of the line across the bridge over the ravine.

Operating Costs

IN December, 1910, the coal consumed was 700 tons, or about 6½ tons a month for each 1000 sq. ft. of radiation, charging all coal to the heating, and none to electrical generation and pumping, as exhaust steam from all units passed through the hot water heaters. With coal at $2.70 a ton, and having a heat value of 12,200 B.t.u. per pound, this cost $17.55 a month per 1000 sq. ft. of radiation for fuel. In January, 1911, the coal consumption was 800 tons, or about 7½ tons a month per 1000 sq. ft. of radiation, charging all coal burned as above. The average amount of radiation turned on was 107,000 sq. ft., and the lowest temperature on January 4 was 7 deg. above zero. Water circulated that day averaged 2200 gal. a minute, and showed a 17-deg. drop, leaving the power house at 184 deg. and returning at 167 deg. This record checks

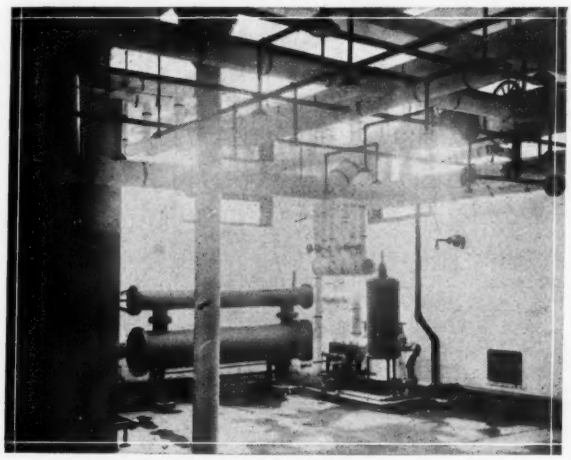


FIG. 16. HEATING PLANT CONTROL AND HOT WATER HEATER IN DORMITORY BASEMENT

up very closely with the coal consumption as figured theoretically, which called for 7 tons a month per 1000 sq. ft. of radiation at the temperature recorded. As some steam was used during that month, for testing about the buildings, the result checked very closely with that as calculated.

Where the central heating plant can be combined with the electrical power plant as in this case, and where the power and pumping plants consume less steam than the total needed for heating, the economy is great, as only about 10 per cent of the cost of generation of the steam should properly be charged to electrical generation and pumping. Costs for operating the plant have been figured as follows:

One power plant engineer	$5.04
2 watch engineers at $4.00	8.00
3 engine and dynamo tenders at $2.48	7.44
3 pump and refrigeration plant tenders at $2.00	6.00
6 firemen at $2.00	12.00
3 laborers at $2.00	6.00

making a total of $44.48 a day for labor, utilizing 3 shifts of 8 hours each. This cost is divided in the estimate in the following proportions: Power, $14.48; pumping, $6.00; heating, $18.00; refrigeration, $6.00.

In winter the load will average about 160 kw. or 3,840 kw.-hr. a day, which, at 40 lb. of steam, calls for 153,600 lb. of steam, or 19,200 lb. of coal. 10 per cent of this is 1920 lb. of coal a day chargeable to electric power. Cost for coal will then be about $3 a day, for oil about $1.10, and for labor as above $14.48, or a total of $18.58 a day, which figures out to 0.48 cent per kilowatt hour. There must, of course, be added to this in total costs, interest, depreciation and repairs.

The following contract forms are interesting, as giving values for comparison, but it should be remembered that these costs are as of 1908 and 9, so that the rise in price of materials and higher cost of labor at the present time must be allowed for.

Contract Cost of Installation

Timber crib protection for site of power house and water filtration plans was	$12,950.00
Filling the site was	5,119.08
	$18,069.08
About two-thirds of this is chargeable to power plant, say	12,000.00
Power house and stack complete was	116,663.00
R. R. trestle to roof of power house	9,998.85
Power plant equipment, was	127,381.71
Distribution mains and tunnels was	124,188.73
Refrigeration plant, circulation mains and cold storage rooms was	30,995.00
Submarine water intake, crib and pumpwell, etc, was	17,830.00
Coal crushing plant, hoppers and cars	4,600.00
Ash handling equipment	3,700.00
Outside lighting, arc poles and cables	5,516.00

Record Costs of Installation

THE following tables give the actual cost of installation of the power plant equipment and distribution mains, tunnel and conduits. The unit prices for material are not exact, as these could not be obtained from the contractors. They are, however, closely approximate. The cost of labor is given as kept by inspectors' daily records, and is, therefore, exact, as are also the quantities. The tables do not cover contractors' profits and certain indeterminate overhead charges.

RECORD COSTS, POWER PLANT EQUIPMENT

Quantity	Description	Labor Unit Price	Labor Extensions	Material Unit Price	Material Extensions
136 cu. yd.	Excavation,	.943	126.99		
427 cu. yd.	Sand fill,	.457	195.00		
5,535 cu. yd.	Concrete foundations,	3.042	1,683.88	4.34	2,402.72
598,800 lb.	Machinery unloaded,	.004	2,458.75		
1,800 B.H.P.	Boilers, B. & W., del'd.				19,846.00
1,800 B.H.P.	Boilers, B. & W., unlo'd	.195	351.00		
1,800 B.H.P.	Boilers, B. & W., erected	.862	1,551.67		
1,800 B.H.P.	Brickwork (150 M.)	1.39	2,503.04	1.17	2,100.00
1,800 B.H.P.	Testing,	.076	136.00		
1,800 B.H.P.	Stokers (Roney),	.202	363.60		6,000.00
1	Crane (7-ton) Maris,		60.00		525.00
94.6 Lin. ft.	Breeching,	7.63	721.60		1,600.00
2	Coal weighing hoppers,	91.10	182.20	400.	800.00
14	Pumps,	20.30	284.30		9,500.00
	Ash tunnel work and cars,		166.00		250.00
92,000 lb.	Piping, specl. valves, etc.	.0301	2,770.50	.16	14,720.00
39,284 lb.	General framing,	.0196	769.05	.035	1,375.00
525 kw.	Engines (Bates-Corliss),	.674	354.00		7,200.00
525 kw.	Generators (Western E.),	.488	256.30		7,680.00
95 kw.	Exciter sets,	1.08	102.80		3,500.00
	Transformers,		58.40		1,200.00
	Switchboard,		340.60		3,200.00
	Electrical connections,		851.90		1,200.00
	Gage boards,		106.40		190.00
6,092 sq. ft.	Heaters,	.0388	236.00	1.40	8,500.00
1,964 gal.	Hotwell and condenser tanks,	.02	39.80	.112	220.00
	Pipe covering,		1,513.45		2,000.00
	Painting,		249.45		40.00
	Miscellaneous work,		630.31		
	Superintendent and general expense,		5,144.70		
			$24,207.69		$94,048.72
	Total for labor and material,				$118,256.41

RECORD COSTS

Distributing Mains for Steam, Water and Electricity; Tunnels and Conduits

Description	Quantity	Unit Price, Labor	Extensions
Engineering, superintendence and general expense,			$ 8,915.24
Excavation for tunnel,	7,318 cu. yd.	.7313	5,351.67
Excavation for conduits,	12,061 cu. yd.	.3181	3,836.41
Backfill and grading tunnel,	7,300 cu. yd.	.3968	2,897.10
Backfill and grading conduits,	8,941 cu. yd.	.2184	1,952.47
Concrete in tunnel labor,	2,123 cu. yd.	4.0884	8,679.79
Concrete in conduits labor,	733 cu. yd.	8.4281	6,177.82
Temporary trestle over ravine,	215 lin. ft.	1.833	394.09
Pipe and fittings unloaded,	366.2 tons	1.448	530.26
Pipe and fittings erected,	45,000 lin. ft.	.282	12,688.55
Tunnel drains, labor,	6,000 lin. ft.	.0374	223.93
Pipe covering,	33,162 lin. ft.	.1184	3,925.99
Painting and waterproofing, labor,	5,070 sq.yd.	.1872	949.24
Vitrified conduit labor,	17,160 duct. ft.	.0205	352.73
Cable wiring and electrical work,			6,819.74
Miscellaneous and general labor,			1,645.15
Total for labor			$65,340.18

Material		Unit Price, Material	
Cement, tunnel concrete,	2,742 bbl.	1.30	$3,564.60
Stone, tunnel concrete,	1,718 cu. yd.	1.15	1,975.70
Sand, tunnel concrete,	891 cu. yd.	1.00	891.00
Cement, conduit,	812 bbl.	1.30	1,055.60
Stone, conduit,	584 cu. yd.	1.15	671.60
Sand, conduit,	294 cu. yd.	1.00	294.00
Reinforcing bars.	56,540 lb.	.025	1,413.50
Lumber forms,	47,800 ft. BM.	22.00	1,051.60
Lumber, trestle,	8,750 ft. BM.	16.00	140.00
Paint, asphalt,	665 gal.	.50	332.50
Structural steel,	22,735 lb.	.0243	552.50
Expansion tank,	1		300.00
Cast iron covers, etc.,	24,000 lb.	.0339	814.96
Pipe covering,	33,162 ft.	.222	7,361.64
Miscellaneous material,			250.42
Transformers,	561 kw.	6.86	3,848.46
Vitrified conduit,	10,546 duct. ft.	.05	527.30
Cable,	36,000 lin. ft.	.172	6,192.00
Cable racks,	1,346	.35	471.10
Iron conduit,	1,360 lin. ft.	.15	204.00
Fuse and generator boxes,	120	13.50	1,620.00
Thermometers,	24	7.00	168.00
Pipe and fittings, valves, hangers, expansion joints, etc.,	45,000 lin. ft.	.812	36,540.00
Total for material			$ 70,240.48
Total for material and labor			$135,580.66

NAPHTHALENE AS A COMBUSTIBLE FOR EXPLOSION MOTORS

By J. H. Blakey

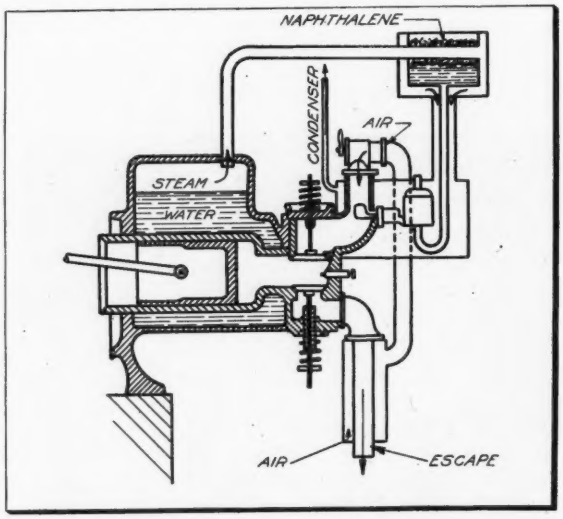
CONTINUALLY increasing price of the carburants now in use for explosion motors is leading motor builders to seek a sufficiently volatile hydrocarbon furnishing motor power at low cost. They have been, in many cases, induced to choose naphthalene, which is one of the by-products of the distillation of coal tar, collected at a temperature of about 172 deg. C. It is a white crystalline material, with the formula C H, of a density 1.15, melting at 198.5 deg. F.; its density at the melting point is 0.98, and the vapor tension at 212 deg. F. is 0.531 in. of mercury. Its calorific power is 17,460 B.t.u. per pound; that of benzol being 17,995, and that of some of the essence of petroleum reaching 19,840.

From the chemical point of view, naphthalene is one of the series of aromatic hydrocarbons having the formula $C_{10}H_{18}$; it contains 93.7 per cent of carbon, and on account of this fact is more difficult to burn completely than the other hydrocarbons generally employed. The European production of naphthalene is about 350,000 tons annually, and its price in the crude state (suitable for use as a combustible) varies from $14 to $28 a ton, according to the locality.

At the present time there is extracted from coal tar only sufficient naphthalene to avoid the crystallization of the oils, which fact explains the small production. The advantages of its employment as a combustible in explosion motors are, first, its low price, and second, its safety in handling. But, on the other hand, the fact that it is a solid at ordinary temperatures, and must be heated before it can be used in the motor, is undoubtedly a disadvantage. As it contains a very large proportion of carbon, it is necessary to mix with it a large amount of air in order to form the explosive mixture. This brings the cost of operation so low that with European prices the cost per horsepower-hour varies from 0.7 to 1.4 cents.

The second advantage arises from the fact that it is noninflammable; even in the liquid state a flame is communicated to the mass only with considerable difficulty, and may be extinguished with water; in case of its escaping from the reservoir, it solidifies immediately.

Naphthalene presents still another advantage over the coal oils at present in use: it is of very definite composition, so that it is always the same; consequently, a motor which has once had its mixture and compression determined will always give the same efficiency. This is not true of the combustibles now in use, as it is hardly possible to get 2 samples of them absolutely alike.



CARBURETOR FOR NAPHTHALENE ENGINE

To sum up, naphthalene motors have a certain future in cases requiring continuous running, such as in providing power for factories, in long distance transportation, and in many agricultural operations.

At the present time the problem of naphthalene motors is only partially solved, as the manufacturers have, till now, constructed carburetors only for the purpose of using naphthalene in ordinary explosion motors, under satisfactory conditions. These may be appliances for using naphthalene dissolved in a combustible liquid, or devices for employing melted naphthalene. Benzine, at the ordinary temperature, dissolves 34 per cent of naphthalene. It would therefore be possible to replace a considerable proportion of this costly combustible by naphthalene, but the evaporation and consequent cooling of the benzine causes a deposit of the naphthalene in the tanks and connecting pipes; this method of using it has therefore not proven satisfactory.

The carburetor shown in the accompanying drawing was patented in Germany in 1906; it utilizes the vapor from the cooling water for the melting of the naphthalene. It is of the ordinary nozzle type, fed by air heated by circulation around the escape pipe. The naphthalene tank is crossed by a steam pipe proceeding from the cooling water chamber, and before reaching the conden-

ser this steam circulates in a jacket which completely surrounds the reservoir, the feed pipe, the carburetor and the admission pipe.

Several hundred single-cylinder horizontal naphthalene motors of from 4 to 20 hp. are now working in Germany; the Gasmotorenfabrik Deutz indicates an average consumption of 300 grams (about ⅝ lb.) of the combustible per horsepower-hour for a motor of 10 hp.—Bulletin des Ingenieurs Civils.

GAGE GLASSES

Why They Break. Hints on Avoiding Breakage

By Richard Thiede

RECENTLY I have seen in Practical Engineer several complaints of gage glasses breaking without apparent cause, and generally right after cleaning them. Now we all know that there is no effect without a cause and having been employed for several years by a firm which imported and handled thousands of gage glasses, I have had some chance to observe them.

Gage glasses are very fragile and should be handled as carefully as eggs or other delicate objects. One of the most common causes of breakage I have found to be small cracks which could hardly be noticed, yet where the glass would break there would be found a small spot of a different color from the break, usually on the inner edge of the fracture. Letting the glass come in contact with metal, holding in the hand at one place, cutting it with a file or laying it on an uneven surface, are all causes of fracture.

A common cause of breakage is laying the glass on an uneven surface, such as work bench or board; as few glasses are really straight, they do not lie evenly, but usually touch at 2 or 3 points only so that any sudden jar or change in temperature will fracture them.

Blowing through the glass is another cause that may sound absurd, yet will cause fracture. Few glasses are evenly round or without seams in them, and if the packing nuts are a snug fit so that there is not sufficient room for expansion the glass will break. Oftentimes the glass is a little too long, or the cocks are not in line, or the ends of the glass may touch the inside of the cocks. Also the washers may be too hard. All these are causes for breakage and should be carefully watched.

Never try to use washers that have become hard or been leaking as a little water on the side of the glass will cause a change in temperature, resulting in a fracture. Scraping the label off with a sharp edge is not good. It is better to soak it in warm water until the labels come off. Do not remove the glasses from the original package until ready to use them as needless handling should be avoided at all times.

The gage glass is no exception to queer breakage of glass articles. Did you ever notice how a window pane which has been in service for a long while will break suddenly, or the sudden snapping of a lamp chimney or did you ever see an incandescent lamp bulb break of its own accord? Just so with gage glasses. They do not break without a cause and the main cause seems to be sudden changes in temperature.

At one time I placed a half dozen glasses on the cylinder of my engine, one end resting on the metal, the other on a piece of waste, and left them there for some time; I then placed one on the boiler column, one on the heater and the third on a cold water tank. The boiler glass broke almost immediately with the heater glass next and the tank glass lasted for some time as there was little pressure on it. The other 3 glasses were laid aside and examined afterwards carefully and were found to have minute fractures near the end that had rested on the engine cylinder.

At another time I was called on to go to a nearby distillery where there was trouble with the vat glasses. As one vat seemed to break more glasses than any other, after examining the broken glass and asking the attendant how he had placed it, I found the cause to be in the handling of the glass. This glass was removed nearly every day and cleaned by pushing a small sponge through with a stick. As the glass was rather long it was necessary to hold it with one hand near the center, and the temperature of the hand was sufficient to cause the fracture. The glasses always broke at or near the center. After suggesting a change in the manner of cleaning, no more trouble was experienced from that cause.

At one time a test was made to ascertain whether the method of cutting had any bearing on the lasting qualities of the glass, and we found that the glass cut from the outside with a fast revolving steel disc, similar to a circular saw, gave the best service. This method is used at the factory where glasses are made. Under no circumstances are they allowed to come in contact with metal except at the cutting point, and they are handled very carefully throughout. In cutting glasses, do not allow the wheel of the cutter to scrape along the inside; the same holds good if you use a file or steel to cut them with. A good way to cut glasses is with a piece of twine. Take a loop around the outside and hold a small piece of wood at the point where the glass is to be cut; fasten both ends of the twine so that it will be tight and move the glass quickly from end to end of the twine. Wet the heated place a little and the glass will break easily.

This can be done rapidly or you can get someone to hold the glass while you pull the string back and forth.

The United States Civil Service Commission announces an examination for assistant engineer in forest products, for men only, on May 21 and 22, 1913. From the register of eligibles resulting from this examination certification will be made to fill vacancies in this position in the Forest Service, for duty at Madison, Wis., and elsewhere as they may occur, at salaries ranging from $1200 to $1500 a year. Competitors will be examined in the following subjects, which will have the relative weights indicated: 1. Technique of drying, treating, and testing timber, 25; 2. Mechanics and mathematics (mechanics, elementary laws and problems with special reference to flexure of beams under static and impact loading, elementary hydraulics; mathematics to and including elementary calculus), 25; 3. Drafting, and machine and structural design, 25; 4. Education, training, experience, and fitness (including undergraduate education and training, postgraduate training, university education, or other training of a similar nature, and practical experience in research or industrial work), 25. Applicants must have reached their twentieth but not their fortieth birthday on the date of the examination. Persons who meet the requirements and desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., for Form 1312. In making application use the title, "Assistant Engineer in Forest Products (Male)."

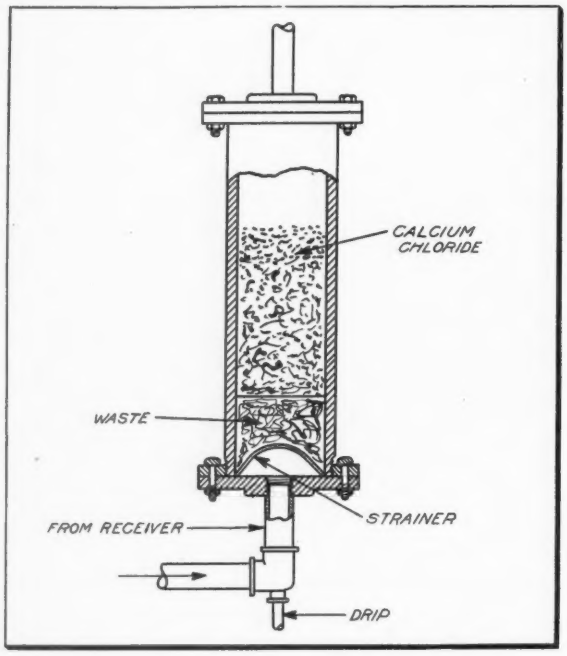
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

AIR COMPRESSOR PROBLEM

IN reference to air compressor problem, on page 336 of the March 15 issue, I should say that in a plant of which I was in charge we required dry air for electric condensers and I think the following will answer his purpose as well as it did ours and is easily made.

Take a piece of 6 or 8-in. pipe 4 ft. long with flanges on each end so it can be cleaned out easily.



PLAN FOR DRYING AIR

Connect the discharge from the receiver to the bottom with a drip, and the pipe for blowing out motors from the top. Use a small gauze wire strainer at the bottom, then a small amount of waste, then fill about ⅔ full with calcium chloride. The calcium will absorb the moisture and will have to be renewed occasionally. R. B. R.

AIR COMPRESSOR DIAGRAMS

THE air compressor diagrams shown on page 380 of the April 1 issue, are very interesting. The diagram No. 1 from the steam cylinder shows a mean effective pressure of 48⅔ on the head end, and 44 on the crank end. This difference of 4⅔ lb. ought to be divided up by adjusting the governor rods.

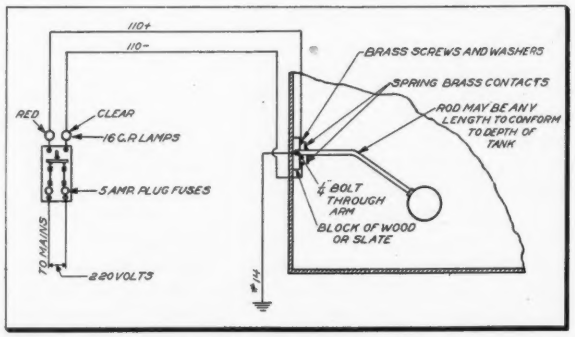
If this engine was not driving an air compressor the release would appear to be too late, but in this case the work in the air cylinder comes during the last half of the stroke, and the pressure in the steam end should hold up as late as possible consistent with good economy on account of the low pressure in the cylinder when the load on the air piston is the greatest. The head end exhaust rod should be adjusted, however, to give a little less compression, this will make the release a little earlier. The expansion curves seem to follow the theoretical hyperbolic curve closely, being below the curve during the first part of the expansion curve and above it during the last part of the curve, which indicates considerable initial condensation and re-evaporation but little leakage in the valves.

The air compressor diagrams are very good except that the crank end inlet valve closes before the end of the suction stroke, while the head end suction seems to close nearly as much too late. The general appearance of the air cylinder diagrams, however, is good. The horsepower of the steam cylinder as shown in diagram No. 1 is 114.3. The horsepower consumed by the air cylinder under the same conditions, except with 1 lb. higher air pressure, is 104.9, showing a difference of 9.4 hp. or a friction load of 8.3 per cent which will show up a little greater with a diagram taken at 29 lb. air pressure, at which the steam diagram was taken.

The steam consumption of the steam engine as figured from diagram No. 1 head end, is approximately 21 lb. per horsepower-hour, which may be considered as representing about 80 per cent of the actual consumption which would be about 26 lb. per horsepower-hour. J. C. Hawkins.

HIGH AND LOW WATER ALARM

THE sketch herewith is for an easily made and cheap high and low water alarm for tanks. A pair of No. 14 copper wires are run from the positive and negative buses of a 220-v. d.c. system to a cutout and switch located on the wall together with 2 ordinary



ELECTRICAL CONNECTIONS FOR HIGH AND LOW WATER ALARM

wall sockets and red and white 110-v. 16-c.p. lamps. Each wire is in series with the lamp and carried to a contact on the wood or slate block mounted on the wall of the tank. The float arm is grounded at the

bolt where it swings in the block and being provided with spring brass clips when contact is made at either lower or upper position, current flows through a lamp to ground, causing the lamp to burn at full candle power, as the neutral wire of the system is grounded. Float arm should be bent downward sufficiently to allow block to be placed above high water line, and made long enough to conform to the depth of the tank or low water line. Contacts on the arm should be adjustable so that any level may be fixed. This may be modified to use bells and batteries instead of the lighting or power current. P. E. F.

A TRANSMISSION PROBLEM

THE problem was presented to me to suggest improvements in the transmission of power over a 0000 wire for a distance of one mile. The load varies from 300 amp. to no load and considerable trouble is experienced with the voltage which at the generator is 250. One thousand feet of 0000 copper wire has a resistance of 0.04906 ohm. In transmitting power a distance of one mile, there would be 2 miles of copper or 10,560 ft. This would have a resistance of $0.04906 \times 10.560 = 0.518 +$ ohms. With a load of 300 amp. the drop would be $0.518 \times 300 = 155$ v. That would leave $250 - 155 = 95$ v. available for use at the brushes of the motor when it was taking full load current, or 300 amp.

This variation of voltage at the motor could be corrected by over-compounding the generator. If on full load the motors require 300 amp. at 95 v., they are consuming 28.5 kw. To consume 28.5 kw. at 250 v. would require only 114 amp., which would cause a drop on the line of $114 \times 0.518 = 59 +$ v. It will be necessary, then, to have the generator over-compounded an amount sufficient to cause the voltage to rise 59 v. for every 114-amp. rise in current. This would keep the voltage constant at the point of distribution, but let us see what the cost will be.

Suppose the load on the line averages 75 amp. for 8 hr. each day. The volts lost on the line $75 \times 0.518 = 38.75$, the kilowatts lost would be $75 \times 38.75 \div 1000 = 2.906$. The kilowatt-hours each day would be $8 \times 2.906 = 23.25$. If it costs 5 cents to produce a kw-hr. then the loss on the line would be $1.16 per day. If the plant operates 300 days a year for 10 yr., then $3480 will have been dissipated, in the form of heat, upon that line.

In the face of these figures I would say: Move the generator as close as possible to the point of distribution.

In doing so about 10,000 ft. of copper wire would be made available for use for other purposes; or if not needed it could be disposed of and should bring no less than $600 even if sold for junk. This amount should be sufficient to defray the expense of moving, as there is no steam power to figure on, in this case. J. M. Row.

EMPTYING THE MINE

ON page 284 of the March 1, 1913, issue, question No. 10 takes up the problem of emptying a ledge in a mine which is 26 ft. long, 8½ ft. wide and 7½ ft. deep. The question is, how long will be required for a 4-in. pump, with velocity of 1200 ft. a minute, to empty the ledge? Two 2-in. pipes are running full into the ledge, at a velocity of 1200 ft. a minute, and the slip of the pump is 10 per cent.

I believe the following method is simpler than that given in the answer. First, find the amount of water the pump will discharge a minute. This, as shown in the problem, is 1049 cu. ft., allowing for the 10 per cent slip. The cubic feet in the ledge figures out as $26 \times 8.5 \times 7.5$, or 1657.5 cu. ft. in the ledge. The amount of water which will flow in through the 2 pipes per minute figures out 52.32, as given. Subtracting this from the 1049, which can be pumped out by the pump, gives 996.68 cu. ft. as the net amount removed per minute. Then dividing the amount in the ledge, 1657.5 by this, gives 1.66 min. as the time required. E. E. R.

ISOLATED PLANT COSTS

I HAVE enjoyed reading Practical Engineer, and I observe that quite a number of interesting articles have been written regarding the cost of current generated by the isolated plant and also the current furnished by the central station.

It seems though, to make a just comparison of cost in each, it is necessary to know the entire expense of the isolated plant, such as interest and depreciation, maintenance and operation cost, etc., and then use this as a basis to work from. I think that there is another method to use and that is this, compare a plant that is buying all the electric energy from a central station or some other source, and take into consideration all the expense incident to that plant, with an isolated plant of same size which develops its own power.

I have in mind a plant that cost $150,000 exclusive of engines and generators, in fact there are no engines or generators in this plant, all machinery is motor driven, there being 50 motors ranging from ¼ to 45 hp., all motors are operated and maintained by the engineering force as well as the heating and ventilating apparatus, plumbing, elevators, and lighting system. The electric current consumption will average 50,000 kw.-hr. a month; there are 30,000 sq. ft. of radiation which require attention and steam for at least 6 months a year. During the heating season an average of 1200 tons of coal has been used costing $2.25 a ton and 6 firemen at $2.25 a day each are employed for that period.

The point for discussion, in my opinion, is this: can the engineer of this plant show a greater saving or less expense to the owner by purchasing current from the central station or some other source, than he could by installing an adequate equipment of engines and generators and generating his own current?

This is the way that I sum it up and I will leave it to the readers of Practical Engineer to give their views on it.

The present plant cost $150,000; the interest and depreciation at 10 per cent would be $1250 a month. The labor cost, 3 engineers, 6 firemen, and an electrician, will average $870.85 a month, figuring the firemen for 6 months and adding it to the yearly expense of labor and then taking 1/12 of that amount for a monthly average. The cost of oil, waste, and packing for motors and pumps averages $50 a month. The coal cost for 1200 tons a year at $2.25 a ton would be an average of $225 a month. Removing of ashes from the plant costs on an average $20 a month. There are a few other items that could be taken into consideration, but as they would appear also against the isolated plant buying current from some outside source they will not be considered at this time.

Summing up, we might arrive at the following conclusion, with all items figured on an average per month per year.

Interest and depreciation at 10 per cent	$1250.00
Labor	870.85
Oil, waste, and packing	50.00
Coal	225.00
Removing ashes from the plant	20.00
Cost of electric current from outside source	900.00
Total average expense for month	$3315.85

Would it be fair and correct for the engineer in charge to report to the owner at the end of the year and set forth that the average current used was 50,000 kw.-hr. and it had cost him $3315.85, and that heating of the building was thrown in for good measure? If this is not correct, why do the greater number of writers of articles and engineers in general allow so little for the heating and general maintenance of a plant and want, as they call it, to "have it chargeable to the switchboard"?

Do the readers of this article believe that it is correct to assume, that a plant, costing not less than $30,000 and increasing the labor cost by one engineer at $100 a month and 6 firemen at $2.25 a day each for 6 months of the year, coal figured at 8 lb. a kw.-hr. at $2.25 a ton, increasing oil, waste and packing, also the interest and depreciation, would be an asset to the owner? Let us see how this would figure out:

Cost of plant	$150,000	+$30,000	$180,000
Interest and depreciation	$1250	+$250	$1500.00
Labor expense	870.55	+ 385	1255.85
Oil, waste and packing	50	+ 20	70.00
Coal	225	+ 225	450.00
Ashes removed from plant	20	+ 20	40.00
	$2415.85	+$900	$3315.85

Would it be correct for the engineer to report to the owner that the plant had turned out 50,000 kw.-hr. of electric current and it had cost him $3315.85?

Again; would it be correct for the engineer to report that the heating and maintenance of the plant in general, not chargeable to the switchboard, had cost him $2415.85 and that the 50,000 kw.-hr. of current had cost sim $900?

S. J. T.

FINDING RADIUS OF FLANGE

IN a scrap heap, left by a predecessor, I found a curved steel flange and being desirous of ascertaining the diameter of a boiler or tank on which it could be used, I derived the following formula.

The problem was, given the measurements FD and CE, which could be obtained from the flange, to find the diameter of a circle whose chord is FD and the perpendicular distance from the circumference to the center of the chord is CE. Let FD be represented by A and CE by B.

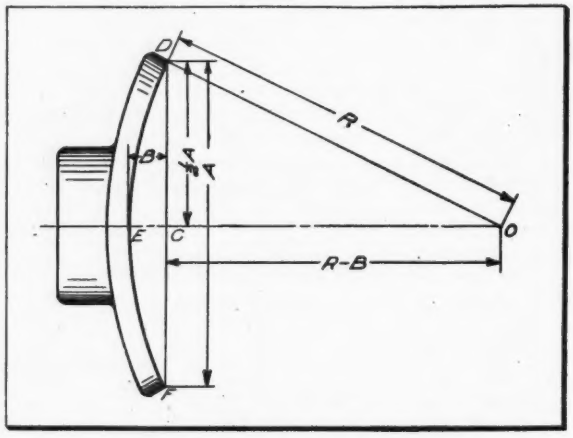
By referring to the diagram it will be seen that OCD is a right angled triangle. Let OD which is the desired radius be represented by R; OE also equals R, so $OC = R - B$ and $CD = \frac{1}{2}A$.

Solving the right angle triangle we have $R^2 = (R - B)^2 + (\frac{1}{2}A)^2$ which equals $R^2 = R^2 - 2RB + B^2 + \frac{1}{4}A^2$.

This reduces to $2RB = B^2 + \frac{1}{4}A^2$ or

$$R = \frac{B^2 + \frac{1}{4}A^2}{2B}$$

In this particular flange $A = 10\frac{1}{8}$ in. $B = \frac{5}{8}$ in. Substituting these values in the formula we have



FINDING RADIUS OF FLANGE CURVATURE

$$r = \frac{(\frac{5}{8})^2 + \frac{1}{4} \times (\frac{81}{8})^2 = \frac{2}{6}\frac{5}{4} + \frac{6561}{256}}{2 \times \frac{5}{8}} \qquad \frac{}{\frac{5}{4}} = 20.82 \text{ in.}$$

This would make the diameter 41.64 in. or the flange is adapted for a 42-in. tank; the small difference in calculated diameter being due to slight inaccuracies in obtaining measurements A and B.

W. Simpson.

SHOULD THE ENGINEER FURNISH TOOLS?

I DO not think that I could get along if I did not have my own tools, as there are few places that are supplied with the necessary tools, even for small repairs.

But, does it pay to buy your own tools? I should say that it certainly does. First of all, work goes twice as easy after you get used to your own tools and you will know better how to overcome difficulties.

Some time ago I took charge of a good sized laundry, and everything was run down, perhaps not on account of any predecessor's ignorance, but because they did not even have a hammer in the place; how could they expect him to do any repair without any tools?

The first week I was there they broke a casing on one of the extractors in the laundry and the owner told me that he would have to buy a new casing; he did not mind that so much, he said, but they were pressed with work just then, and he did not have enough extractors even with this one that broke down. He could not see, he said, how he could get the work done.

I told him if he would send the casing over to the engine room, that I could fix it for him in a short time. The next morning he had it sent over to me, and I went to work on it. He came around about 2 hr. afterwards and I told him it was all done. Then he looked at the tools that I had lying on the floor, and he asked where I borrowed all those tools. I told him they were my own tools. "That's funny," he said, "I have never yet seen an engineer here that had any tools."

I told him that I had tools enough to do my own repairs if the job was not too big for one man to handle.

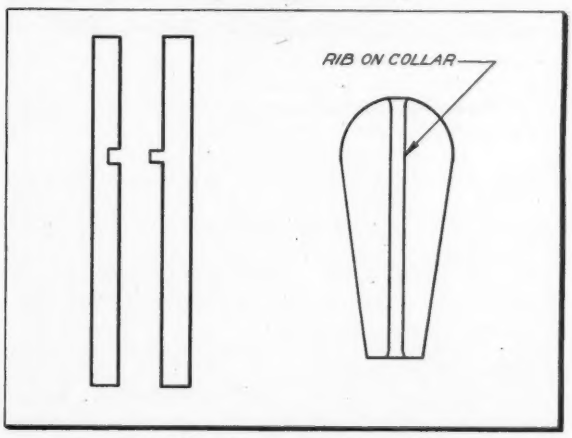
He went away surprised, but I was not a bit surprised the next pay day when he came around and said that he had raised my pay $2 a week. I did not stay there long, but I did many small repair jobs before I left, and he also raised my pay another $2, and no doubt I could have had more if I had stayed there.

It surely does pay to have your own tools. Besides, it is very interesting to be able to do different kinds of jobs, and a man will learn a great deal, and get a good many valuable ideas by turning his hands on everything in the place where he is working.

It is hard to state just what tools an engineer should have, as that depends first on his ability and second on whether he can afford to buy them, but I always have a few tools with me; these are a 10-in. Stilson, a pair of 8-in. nippers, a pair of 8-in. plyers, a pair of inside and outside calipers, a small flat file, a sharp cold chisel, a 6-ft. rule, a small peen hammer, a screw-driver and a bicycle wrench. A man could keep those few tools handy in a cigar box, and he will always be able to do small jobs that come along. M. C.

POSITION OF GATE VALVES

I HAVE often read in Practical Engineer and other books regarding the proper position for a globe valve but I have never to my knowledge read any discussion on the proper position for a gate valve. Some time ago I had occasion to repair a 2½-in. water line on which was a gate valve. The valve had the spindle pointing downwards. We shut the valve, or thought we did, to make the repairs but it would not shut off the water, so we had to shut the valve on the main line to make the repairs.



DISCS AND COLLAR OF GATE VALVE

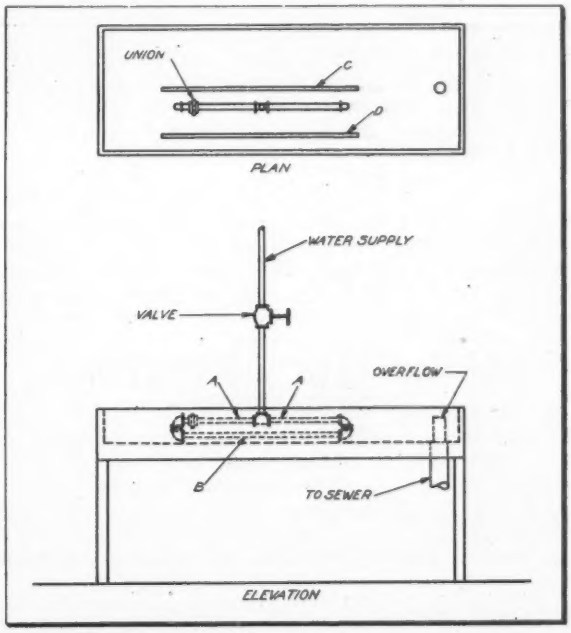
While we were making the repairs the valve was taken apart and examined but everything seemed all right, so it was put back again. The other day I had occasion to make repairs on the same line when the valve would not close again which meant closing the main and to get permission for which one has to go through a lot of red tape. This time I took the valve off and put a new one in its place. The reason I did not take the valve off the first time was because I had three sections of pipe to take down before I could get the valve off, as that was the nearest union to the valve.

The old valve was taken over to the workshop and tested. We tested the valve without doing anything to it and found it just as good as a new one. The only difference being the valve stem was pointing upwards under the test. After the test we opened the valve to let the pressure off then turned the valve half a turn so as to let the stem point downwards which was the position it was in when it failed to work. We then proceeded to close the valve again when we found it would not close more than half way. The disc was in 2 parts which is common practice in gate valves of 2½-in. size. Upon investigating we found that in closing the valve, after being wide open, the discs would fall away from each other allowing the collar on the spindle to travel faster than the disc so that by the time the discs got about ½ of the valve opening closed they were locked fast and it was impossible to close the valve with the stem pointing downwards, the collar on the spindle simply acting as a wedge holding the discs apart. We have had to turn about half a dozen of these valves with their stems upwards as we found after testing them that they would not close with their stems pointing downwards. John Mitchell.

BLUEPRINT WASHER

ACCOMPANYING sketch shows a blueprint washer which will wash the print without leaving streaks. It consists of a regular washing tank with an overflow pipe into which is put the special washer.

A ¾-in. water supply is connected with a valve which is set within the operator's reach and from this runs a length of pipe into a tee and from this tee run 2 pieces of pipe which are marked A. These pieces of pipes are drilled with a ⅛-in. drill every ½ in. on the under side. B is a piece of wood on which the paper can drag easily.



PLAN AND ELEVATION OF BLUE-PRINT WASHER

To operate the washer, the print is rolled on a stick marked C and then the paper is pulled through the space between A and B and rolled on stick marked D and then hung up to dry.

The only time that the valve should be open is when the operator is washing a print. With care and practice an operator can soon learn at what speed to draw the print under the spray to get an even color and thoroughly wash the print. J. M. S.

METALLIC PACKING

IN the April 1 issue, Mr. Mason asks about the use of metallic packing in the water ends of pumps, I will say that if proper packing for the work is secured it works as in an engine; where a great amount of trouble with this kind of packing is experienced is with composition rods that change with the temperature of the liquid pumped, which causes leakage; and tightening up spoils the rods. If any grit gets between the rod and packing the rod will be cut or flutted, take the case of a boiler feed pump working from an open heater with a temperature, say of 125 deg. and the pump showing no leakage, then run cold water in the heater, a leak starts and setting up on the gland stops it until the temperature of the water rises and friction starts, which soon wears this rod. So it is best to keep the water near an even temperature and let leakage come on and change, just as in an engine when the doors are open on a cold day, and all the glands leak for a while.

I have used the ring type packing on composition rods in the feed pump and oil pumps for 5 yr., with entire satisfaction and the first packing put in has not been removed, only added to a ring at a time on the steam and water ends of each, the feed pumps handle hot water at a temperature of 200 to 210 deg. continuously without any leakage, although I had 2 rods spoiled before we secured the right kind of packing and one rod that had been working 8 months was spoiled in an hour by a green man tightening the gland which he said he found loose and did not know that gaskets were to be kept otherwise than tight. We had some trouble securing a packing for an ammonia pump which circulated hot weak liquor until we used cast-iron rods which cured the leakage. To secure the results we put the matter up to the packing man with the guarantee that if the rods were spoiled they would be replaced if their instructions were followed, which I think is the best way to try this kind of packing, as there are some brands on the market that would not pack any kind of a gland and some makers say "what we make we find some one to take," which is usually the engineer who does not know much about metallic packing. I will say that I have found metallic packing the ideal thing to put in almost any gland when it is set for the work. D. F. C.

DRILLING SLATE; UNDERCUTTING COMMUTATORS

NEARLY every reader of Practical Engineer has had to drill slate or marble some time and most of them know that it is rather hard on a twist drill. From my own experience I have found the reason why a drill ground and tempered for metal soon dulls and then "squeals," and if forced the cutting edge gets purple and is rolled over.

All that is needed for marble is to scrape away the material and no power or strength is needed to force up any chips.

If a drill of size needed is ground back from cutting edge say 2 or 3 times as much as for metal, you will have a cutter as shown in the sketch, dotted line standard grind for metal and solid lines as ground for marble.

Heat end of drill to a dull cherry and dip into salt water about as deep as the diameter of drill. This will harden short section at point much harder than the marble and it will scrape away a long while before needing a grinding.

If care is taken all the drill can be used and ground without drawing temper.

When through warm the drill till it comes to a brownish yellow and quench, then grind for metal and your drill is as good as ever.

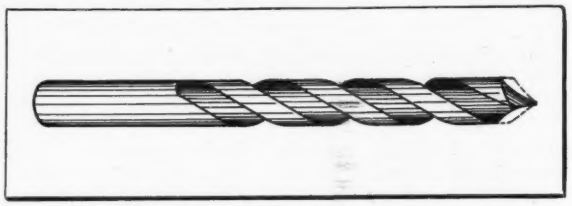
For large holes, over ¾ in. use a 3/16 or ¼-in. hardened drill first to get a lead for large drill point. I have put ¾ and 15/16-in. drills through 2-in. marble with an ordinary carpenter's brace with ease.

The drills thus ground have no tendency to squeal, as the metal at rear of cutting edge is away from the material.

We all know that cutting down mica in commutators generally cures sparking and eliminates 90 per cent of brush trouble, yet I have had cases where, on slow speed motors of 250 hp., 250 v. reversing mill type, this did not work and instead of cutting down mica I took a hack saw blade and scraped the mica lengthwise of bars with back of blade.

You can soon cut mica down to level of the copper this way and a light sanding will remove all tool marks and clean up the rough edges. This can be done any time with the armature in place and if all are not scraped down at one time no harm can result.

After sanding a commutator and fitting the brushes one often has trouble shortly afterwards with brushes sparking. If when this first starts you will take out a brush and look at the end you will find little shiny points of copper embedded in the carbon.



DRILL GROUND FOR DRILLING SLATE

These points cut the surface of the commutator and also hold the rest of the brush up away from the bars, the entire spring tension being brought to bear on the copper points.

Do not sand brush if possible to pick out the copper with scraper point or rubbing hard with a cloth.

The brushes are now nearer a true bearing than possible with sandpaper.

If copper is kept out till the commutator attains its chocolate colored surface the brushes will show a beautiful, smooth surface that fits the copper exactly. The commutator will take its gloss much sooner also as there is no cutting going on to delay the process.

Any time you see a commutator with many small grooves running around the circumference you can feel sure that copper in brushes caused this right after the machine was turned up and sanded. A little care at this time will soon repay you.

I do not believe in eternally grinding away at a motor or generator with sandpaper block, this removes the effects of the original cause and at same time furnishes fresh trouble. Of course, a machine needs sanding occasionally, but it is like keeping ice on a hot bearing, day after day, better see what causes the heat rather than remove it after generated.

Chas. M. Green.

THE BEST LESSONS a man can learn are from his own mistakes.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Questions Concerning Plant Operation

WHAT is the difference between an inertia governor and a centrifugal governor?

2. How would you get scale out of a water-tube boiler?

3. What would cause an Ames engine to race?

4. If the governor on an Ames engine stuck in the outer position under full load or stuck before it got into outer position on full load what would the engine do?

5. If a boiler bagged what would you do?

6. How do you measure a bag?

7. Explain the Webster vacuum heating system, also the Paul?

8. Is there any way of testing a vacuum breaker on a jet condenser?

9. How do you start and stop a condensing engine?

10. If a safety valve blows back too much steam, which way would you screw the blow back ring, up or down? A. A. W.

A. In the centrifugal governor, the moving power is purely centrifugal force. This is the earliest type of flywheel governor, and was used in its purely centrifugal form by the Buckeye Engine Co., who still use it. Usually 2 heavy weights on the ends of 2 arms act by centrifugal force against the tension of springs, and in this way turn the eccentric about the shaft to change the lead of the valve. There may, however, be various modifications in the details of the governor, but there is always the condition of 2 weights acting by centrifugal force purely.

In the inertia governor—of which the Rites, as used on most of the automatic high speed engines today, is the most common—there is a heavy bar which acts partly by centrifugal force and partly by inertia; that is, as the engine tends to speed up, the weight of the bar tends to hold it from taking on this increase of speed, and thus changes the position of the eccentric. Most commonly this change is swinging the eccentric across the shaft, so that it changes the travel of the valve. It may change the lead or not, according to the design of the governor.

If you have a copy of the January 1, 1913, issue, you will see the example of the inertia governor on a number of the engines there shown, as, for instance, the ABC on page 15. An example of the centrifugal governor is not shown in the issue, as it is little used at the present time; but a form of governor which uses largely centrifugal force is that of the Ball engine, shown in Fig. 3, page 18. In this, however, the governor weight does act partly by its inertia.

2. About the only way to get scale out of a water-tube boiler is by use of a tube cleaner. A properly-made boiler compound will prevent largely the formation of scale, and several firms are now advocating graphite as a scale remover and scale preventive; but after scale has once formed in considerable quantities, removal by any graphite or compound process is necessarily somewhat slow, and for quick removal the tube cleaner is the most satisfactory method.

3. The matter of racing of governors is discussed in the January 1 issue, page 80. While the Ames governor is not quite of either the Armstrong or Rites type, the conditions which will make it race are practically the same. Either friction in the governor mechanism, or a governor set too sensitive will produce this result.

4. Your question is rather puzzling, as the governor should be at full load in the inner position rather than the outer. Of course, if the governor sticks in the outer position at full load, the engine will not be getting enough steam and will slow down.

7. In case of a bagged boiler, there are 2 courses: If the bag is not very severe, and use of the boiler at once is essential, the bag is sometimes driven up by careful hammering from the outside, beginning at a point somewhat outside the apparent effect of the bag, and hammering around and around, gradually drawing in nearer to the center—not trying to reduce the entire deformation on the first going over, but working it up gradually until the bag has been brought back into position. Of course, this should be regarded as only temporary, and the plate should be removed and replaced with a new plate as soon as possible.

Patching over a bagged surface is not good, as it forms a weak spot over the furnace and is likely to make further trouble. If the bag is bad and a temporary repair must be made, the area, somewhat larger than the bagged spot, can be cut out and a patch put on the inside of the boiler. The patch should not be on the outside, as this forms a pocket where sediment will accumulate and be sure to make trouble. In any case, it is well, if possible, to have an inspector examine the boiler if a temporary repair is made, before the boiler is put in service again.

6. The measurement of a bag is usually the depth from the normal position of the plate to the deepest point of the cavity. It is well, also, to give the distance across the bag, as this gives an idea of the extent of the plate affected.

7. The Webster vacuum heating system is fully described in the catalog of Warren Webster & Co., Camden, N. J. It would be best for you to write them for their catalog on this. The Paul System Co. do not issue a catalog, but you will find a description of their system in the issue of Practical Engineer for May 1, 1912.

8. The way to test a vacuum breaker would be to produce artificially the conditions against which the breaker is supposed to safeguard; that is, stop the pump which removes the condensed steam and water from the condenser, or, if it be a barometric condenser, close the outlet valves. The tendency then would be

for the condenser to flood, and, of course, the vacuum breaker is supposed to open the condenser so that atmospheric pressure will enter.

9. The chief precaution in starting a condensing engine is, that vacuum is produced in the condenser before the engine is started up—that is, the vacuum should be started, but it is as well not to turn on the cooling water fully until after the engine is in operation. In shutting down, the vacuum should be kept running until after the engine is stopped, so that there will be no danger of the water backing up and flooding the cylinder.

10. In case a safety valve blows back too much before it closes, the blow-back ring should be screwed up so that the valve disk will enter it sooner.

A. L. R.

Overheated Babbit

WILL babbit, after becoming hot enough to run, cool of its own accord under the same stream of oil and under very nearly the same load, or what would you attribute as the cause of finding thin sheets of babbit in a bearing? M. L. R.

A. As a rule when a babbit bearing gets hot enough to run out of box, it is past redemption and has to be remetaled, but it sometimes happens, with some grades of metals, that when the bearing becomes quite hot the surface wipes off and goes up towards the joint, and this relieves the bearing to the extent that it can be run under the same load and with the same oil until the regular stopping time. A bearing will also sometimes flake off in thin sheets if it has been poured around a cold mandrel.

The metal does not really get hot enough to run, but the surface when quite hot (about 300 deg. F.), softens and it is this soft metal that wipes off or squashes out as the case may be. Sometimes the journal is not level or is out of alinement, and fortunately the metal is displaced in this way, otherwise more serious things might happen.

Our experience is that genuine babbits (tin base metals) won't wipe off, and as a result they "go down" when the temperature reaches around 300 deg. F.

As the fusing point of babbit is around 500 deg. F., you can understand that the metal really doesn't run in the box, but the surface squashes as it softens from frictional heat. F. Jordan.

Flow of Water in Pipes

WILL you please give me a formula for calculating the amount of water in gallons that a pipe will discharge? For example, a 2-in. pipe 1 mile in length with water under 40 lb. pressure. Is there any more friction in a short bend of a pipe than there is in a long bend? V. K. S.

A. The question of flow of water through a pipe is one in which there is a chance for large difference in figuring, chiefly because the formula is rather complicated and the constants from experiment are not very accurate for small pipe.

Suplee gives a formula as follows, based on tests made in 1896 by Tutton:—The velocity in feet per second equals the square root of the slope, times the cube root of the square of ¼ the diameter, times a constant which for wrought-iron pipe is 160. The slope in this case is the ratio of the head to the length. In your case the slope would be $40 \times 2.31 \div 5280$, which should equal 0.018. The diameter of a 2-in. pipe is 2/12 of a foot, and ¼ that would be 2/48, or 1/24, which is approximately 0.0416. The square root of 0.018 is 0.134. The square of 0.0416 is 0.00174, and the cube root of that is 0.1203. We then have the velocity is equal to $0.134 \times 0.1203 \times 160$, which equals 2.57 ft. per second. We would then get the quantity flowing by multiplying the area of the cross section of pipe by the velocity, which would give us cubic feet, and that by 8⅓ would give us gallons per second.

Suplee's Handbook has worked out a table—page 531—for the discharge of water from smooth wrought-iron pipes, in which he gives for a slope of 0.018 about 0.05 cu. ft. per second, for a 2-in. pipe. This ties up with another table which he gives, because 0.05 cu. ft. per second would be 3 cu. ft. a minute; and at this discharge, according to the other table, the loss in head per 100 ft. of pipe would be 1½ ft., which in the 5200 ft. of pipe which you have would give 78 ft. loss in head, leaving about 17 ft. as the spouting head at the end of pipe.

I have another equation for the gallons per minute flow, which is as follows:—the diameter of the pipe in inches raised to the fifth power, multiplied by the head in feet, divided by the length in feet, and also by the co-efficient of friction. Take the square root of this last equation and multiply by 2.83. The co-efficient for pipe in bad condition is 0.01; in fair condition, 0.02; in average condition up to 12 in. diameter, 0.06; for pipe over 12 in. in diameter and in good condition, 0.001. Taking the co-efficient as 0.0125, would give a flow of 2.6 cu. ft. per minute, which is not far different from the other method. A. L. R.

Relations of Viscosimeter Readings

WILL you kindly advise what relation exists in viscosity readings of the different makes of viscosimeters; viz: The Saybolt, Engler and Tagliabue, Redwood & Scott and Doolittle. P. J. G.

A. The only way to compare the readings obtained from testing oils on viscosimeters of various makes, is to reduce the readings to absolute viscosity.

This can be done only after each machine to be used has been standardized and its constant obtained over a wide range of viscosities.

The method of standardizing viscosimeters is a technical affair, and could not be successfully carried out except by an expert in that line.

The best book written on the subject is Archbutt and Deeley's Treatise on the Theory and Practice of Lubrication, C. Griffin & Co., Ltd.; but one would have to be more or less of an expert to follow their instructions for procedure with anything like success.

If there is any particular information that the person desires who writes the inquiry, I could undoubtedly offer helpful suggestions. If he is only after general information, I know of nothing better than to advise him to send for Archbutt and Deeley's book.

F. E. Dobbs.

Size Feed Pipe

HOW large should a boiler feed pipe be to care for 3 100-hp. boilers? Discharge pipe to run from the pump and discharge into each boiler under ordinary conditions. J. N. R.

A. In regard to the size feed pipe needed for a 100-hp. boiler, at ordinary commercial rating the water required per hour per horsepower is 30 lb., or for a 100-hp. boiler it would require 3000 lb. an hour. This

would be 50 lb. per minute, which, at 62.5 lb. per cu. ft. would call for 0.8 of a cubic foot per minute.

It is always customary to provide for a rate of feeding the boiler double its normal rate of evaporation, on account of the necessity of filling up rapidly at times, and the velocity usually allowed is 100 ft. a minute. On this basis the quantity to be taken care of would be 1.6 cu. ft. a minute, which at a velocity of 100 ft. would require an area of pipe of 0.016 sq. ft., or 2.3 sq. in. This will be practically a 1½-in pipe. This would be the size to run to each boiler, and for the common pipe for all 3 boilers, to furnish an area equivalent to that of the 3 ½-in. pipes, there would be required, as shown by the Equivalent Pipe Table, an area of 6.9 sq. in., which would call for a 3-in. pipe.

Because all 3 boilers would not likely need the full rate of flow at any one time, it would be safe to use a 2½-in. pipe for the common feed. A. L. R.

Staying Surface of Boilers

WHY does the Board of Boiler Rules (Mass.) allow only 2 in. around the manhole opening, etc., to be deduced from total area to be stayed under tubes, when it allows 3 in. from shell to be deducted from area to be stayed above the tubes? S. A. R.

A. The difference is that around the manhole there is sometimes a flat surface, which has little power of itself to support pressure. Of course, this is usually reinforced and sometimes the edge is turned in, but this is not always done, and the Massachusetts Rules are so framed as to cover all conditions.

Around the outside of the head, the edge is turned over to make the joint with the shell, and this turning over on the edge gives a rounded corner which of itself is helpful in carrying pressure and also the turned-over edge forms a support similar to an angle iron. A. L. R.

Detecting Leak in Heater

HOW can a leak in a closed heater be detected if there are leaking valves in the pump or piping? W. G. S.

A. When in operation, there is in all closed feedwater heaters exhaust steam in contact with one side of the heating surface and the feed water under pressure in contact with the other side. When there is a leak, water will pass into the steam space and be carried out with the exhaust, or will run out with the condensate at the drain.

If a leak is suspected, water under the usual working pressure may be forced through the heater at a time when the engine is not running. If water appears at the drain, it must come from the water side of the heater and it shows that there is a leak.

Leaking valves in the pump or piping would not affect the test in any way. F. L. Johnson.

Price of Steam for Heating

I WOULD like to have your opinion on what you consider a fair price for live steam, horsepower per month. Steam is supplied at 25 lb. gage pressure. I receive all my returns back to the pumps.

Cost of running as follows: Coal $4.65 a ton, coal averages 7 per cent ashes; cost of removing ashes 7 cents for 200 lb.; cost of water 14 cents per 100 cu. ft.; labor at the rate of $3.00 a day; the length of these days are 16 hr. for 300 days a year.

The length of pipe for conveying steam is 100 ft. from boiler. This steam is to be used for steam tables, coffee urns, and for heating water. How much should I charge per horsepower if my customers should ask for the reduction of heat units that I receive in the return water?

A. We find from records of heating companies that a charge of 60 cents per thousand pounds of steam furnished is about the common rate for conditions as you specify them.

In order to check this up, we have made computations as follows: In a 100-hp. boiler the output would be 3000 lb. of steam per hour, at normal rating. Allowing 6 lb. of steam per pound of coal, this would call for 500 lb. of coal, and in a 16-hr. day, for 8000 lb. of coal a day. For a 300-day year, there would be 25 days a month, and this would call for $8000 \times 25 = 200{,}000$ lb., or 100 tons of coal a month, which at $4.65, would be $465.00. If 7 per cent of the coal is ash, it would be necessary to take out 14,000 lb. of ash a month, or at 7 cents for each 200 lb., $4.90 a month, or say $5.00 for ash removal.

Three thousand pounds of water an hour, for 16 hr. a day, and 25 days, would amount to 1,200,000 lb. a month, or 18,700 cu. ft. At 14 cents per hundred cubic feet, this would amount to $26.20.

In your 16-hr. day, you would have 2 shifts, or a cost of $6.00 a day for firemen on the boiler. This for 25 days would give $150.00. The total cost, then, for fuel, labor and water would be $465.00 + $5.00 + $26.20 + $150.00 = $646.20. To this we add 10 per cent for overhead costs, such as interest, depreciation and supervision, or $64.60, making a total cost of $710.80. This is for 100 hp., and for 1 hp. it will be $7.11 per month.

Figuring now from the price of 60 cents per thousand pounds of steam, we found above that the 100-hp. plant would take 1,200,000 lb. of water a month, which at 60 cents per thousand pounds would amount to $720.00, or $7.20 per horsepower per month, which is in reasonably close agreement with the value as found.

As to the reduction for heat in the condensation at 25 lb. boiler pressure, the total heat will be 1154.6 heat units per pound, and the heat in the liquid will be 209 heat units, which is 18.1 per cent. Of course, there will be some loss for radiation, and it would be fair to allow, say, 15 per cent for the heat returned. We should then have 7.11×0.85, or $6.05 per horsepower per month as the price, after the allowance for heat in condensation is taken off. A. L. R.

Correction Note

ATTENTION has been called to the computation for the safe working pressure on a boiler, on page 383 of the April 1 issue, on top of the first column. The computation is,

$$\frac{60{,}000 \times 0.3437 \times 0.74}{27 \times 5}$$

This gives 113 lb. as the safe pressure, instead of 152 as given in the issue.

FRUGALITY IS GOOD, if liberality be joined with it. The first is leaving off superfluous expense; the last bestowing them to the benefit of others that need. The first without the last begets covetousness—the last without the first begets prodigality.

—William Penn.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Valve Problem

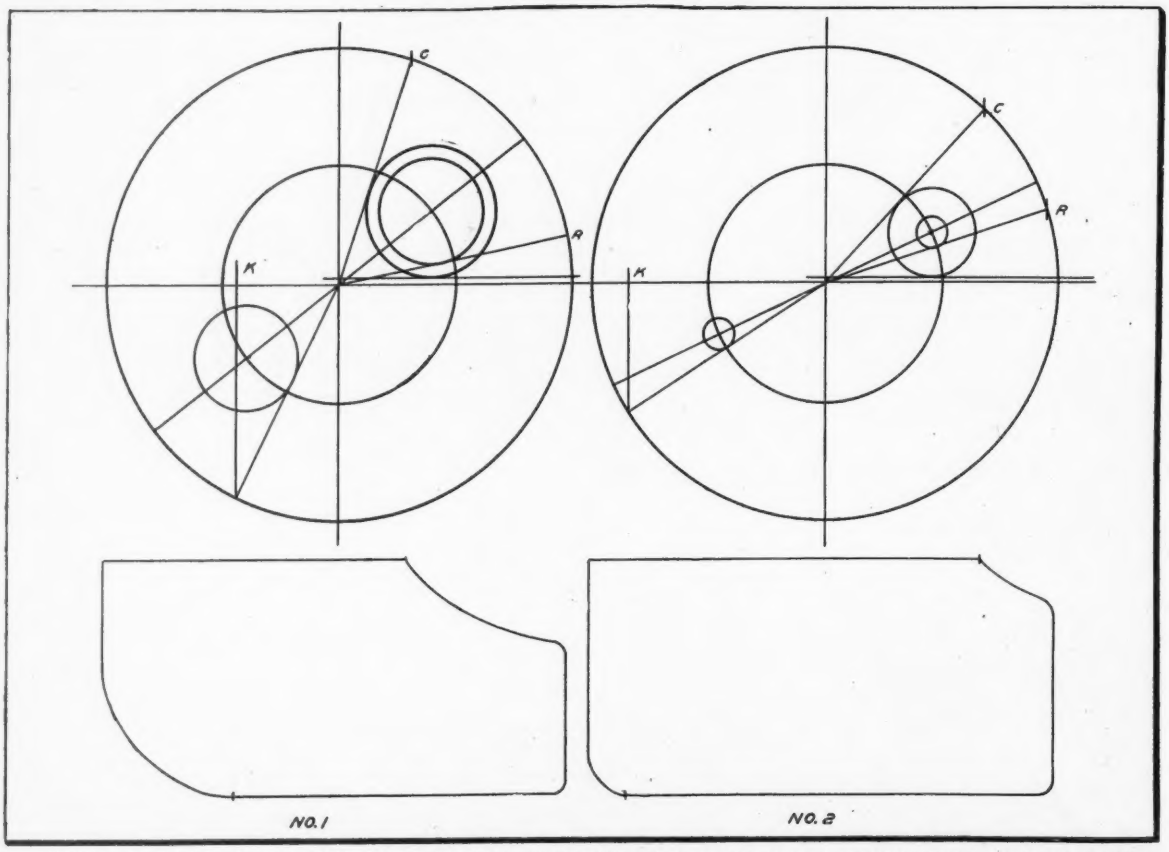
IN answer to valve problem by E. H. Lewis, in March 15 issue, I wish to say that I agree with him in believing that the changes he proposes to make on his valve will give him more power. As near as can be figured, from sketch and figures given, cutoff at present takes place at 66 per cent of stroke or at 10 9/16 in. After taking off ⅜ in. of steam lap cutoff will occur at about 84 per cent or at 13 7/16 in. of stroke. Less work will be done during expansion, which, of course, means slightly decreased efficiency; but since it is a question of power and not economy, this is a move in the right direction.

Release at present takes place at 98.8 per cent or 15 13/16 in. of stroke which is too late, and by reducing exhaust laps to ¼ in. release will be had at 97.6 per cent—15⅝ in. of stroke which should be about right.

Compression now begins at 73 per cent of stroke or at 11 11/16 in., which is altogether too early and with inside lap cut to ¼ in. will begin at 92 per cent of stroke or at 14¾ in., which will mean that less negative work is being done on the piston.

The problem would be more interesting if accompanied by an indicator card as this would probably give a lot of additional information but without considering initial pressure, back pressure, or action of governor, I consider Mr. Lewis' new dimensions well chosen and believe he will get the desired results.

Karl H. Muller.



VALVE DIAGRAMS AND THEORETICAL INDICATOR DIAGRAMS BEFORE AND AFTER SUGGESTED CHANGES ARE MADE

Heater Problem

REFERRING to A. J.'s closed heater problem in your issue of March 1, the suggestions made by J. H. Norton and Chas Boardman in April 1 issue, I hardly think will solve the difficulty. The cause of the trouble is, I believe, two-fold.

1st: The rapid condensing of the steam in the heater due to the flow of cold water through the coils reduces the steam pressure in the heater below

that in the pipe supplying the steam. It is easy to conceive a condition where the pressure in the heater might be below that of the atmosphere, in which case atmospheric pressure would surely prevent the condensation from flowing through the drips as arranged by A. J. or either of the other gentlemen.

2nd: The exhaust steam supply in its nature is pulsating. This had a tendency as it were, to keep the condensation sort of dancing ahead of it in the heater.

My recommendation would be to tap into the bottom of the heater so as to attach a good sized drip entirely separate and distinct from the steam inlet pipe.

It would be interesting to us all if A. J. would advise just how he overcomes his trouble.

Chas. F. Chase.

Massachusetts Examinations

SUBSCRIBER, in the March 15 issue, asks some questions which he wishes answered. The questions are:

1. How are boilers cut out of service?
2. Why are rear heads flanged in and front heads flanged out?
3. How would you proceed in case of low water with the fusible plug blown out?
4. What would you do if the manhole plate fell in with 60 lb. pressure on the boiler?

I should answer those questions in the following manner:

1. To cut the boiler out of service burn the fire down low, and when it is making little or no steam close the steam valve between the boiler and header. Then pump the boiler up to about 3 gages of water, close the damper, and leave the fire and ash pit doors closed so that the boiler will cool slowly to prevent unequal contraction which would set up unequal strains in the boiler. If the boiler is a very large one, however, running at a good load with a hot fire, and on account of an accident it must be cut out immediately to prevent damage to the other boilers on the line, it would be impossible to wait for the fire to burn down, and it would have to be dumped into the ash pit, or if this was impossible on account of the design of the furnace the only means left would be to turn the water hose on the fire. This is hard on the furnace but the usual method of "wet ashes" or "green coal" in the modern power plant is out of the question. In any case of cutting the boiler out whether in emergency or not the blowoff valve should be tried to make sure the boiler can be drained when cold.

2. The rear heads are flanged in to protect the flange and riveted joint from the heat of combustion which is very great at this point, and if flanged outward there would be a ring of metal several inches wide exposed to the direct action of the heat without water to protect it which might get hot enough to weaken the joint, and cause an explosion. The front head is not exposed to such a high temperature, and in some cases it is flanged outward as it is easier to drive the rivets by machine, and the lower half of the shell is extended to form the partition between the furnace and smoke box.

3. The first thing to do would be to get rid of the fire. If the boiler is small it may be covered with wet ashes, or green fine coal, but with stokers in use, and in many hand fired plants it would be impossible to do this, and the only method left would be to dump the fire and turn on the hose, either in the furnace, or better in the ash pit, if possible. Then close the main steam valve cutting the boiler off from the header.

4. The question of a manhole plate falling in against 60 lb. pressure is generally considered to be a catch question but I believe that such a thing is possible. Take for instance the tube cap of a Heine or Geary water-tube boiler. These plates are on the inside with the pressure against them. As long as the gasket is tight and there is no leakage the pressure will hold the plate in place even though the clamp be removed, but if the gasket should leak a little it would tend to push the plate away from the head and as the opening became larger the leakage would push the plate further away until eventually the plate would fall into the boiler. I have had many cases of this kind in which the plate would have gone into the boiler but for the clamp holding it in place, and I think this is a sensible question after all, and would apply equally well to the manhole plate. The fire should be gotten rid of as quickly as possible in the manner stated above, and the boiler cut out from the header. Then it is cooled down as quickly as possible. This may be best done by slightly opening the blow-off valve and putting on the feed pump to keep the water up to about 2 gages until the pressure is off; then stop the pump and let the water drain out of the boiler. All doors should be kept closed. As soon as the water is all out or below the plate take it out and put in another, or put on a new gasket and fill the boiler, preferably with hot water. In a short time it can be put on the line again. J. C. Hawkins.

Shutting Down Boiler

ANSWERING Subscriber in March 15 issue, when taking a boiler off the line let the fuel burn down first until no steam will be generated by its heat. Then cut out from header and your boiler is off the line. Should the pressure rise on it, simply pump in more water and blow out some, maintaining a good water level, and then pull your fire.

With the fusible plug gone the steam will drop very quickly and it is doubtful if you could do anything to the fire for some time after the plug lets go.

The reason heads are flanged in and out is to allow for machine riveting clear through.

There is no possibility of heads falling into a boiler. J. C. Lee.

Oil in Condenser

I NOTE in your issue of April 1, that "Helos" appeals to your readers for a solution to clean out the condenser he has in operation.

It is evident that he is operating a water works condenser, and that the oil in the exhaust is the cause of his trouble. I have come in contact with units being affected similarly, and if "Helos" will take a solution of boiling water, saturated with soda, and pump it through his tubes, he will eliminate this oily accumulation. N. Owitz.

REST IS NOT IDLENESS, and to lie sometimes on the grass under the trees on a summer's day listening to the murmur of water, or watching the clouds float across the sky, is by no means waste of time.

—Lord Avebury.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.

New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright 1912 by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 23,500.

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WAITING

The question will sooner or later come, "Are you ready for a bigger job?" Right today, you may think the question is, "where's the bigger job?" but the chance comes, usually, without warning, and whether the question ever gets to you direct will depend on whether you have laid yourself liable to it by a record of progressiveness and accomplishment.

It's so easy to dream of the fine record we could make if Fate would kindly set us gently down in a position of responsibility. But Fate (and the boss) don't like to take chances, and just waiting is no good way to "show them" satisfactorily. The man who has the bigger job, and is handling it satisfactorily, has earned it in a smaller one.

The job just ahead may not look much bigger, or worth much striving, but it is the gateway to still bigger things and it is the long look ahead to the great big things you want, and the courage to keep after it that wins.

Courage—there's the rub in many cases. Courage to give up present ease and luxury for the joy of future results; to sacrifice and ask our helpmeet for sacrifice in order that greater things may come within our grasp. But courage comes with striving and doing, not with waiting. Waiting kills courage and determination, and leaves fear and hesitation.

Looking at the financial side only from the standpoint taken by President Mudge of the Rock Island R. R., see what even a small advance means. At $1000 a year or $19.23 a week, a man is worth to himself $25,000, for his wages are equal to 4 per cent on that amount. If he wins a raise to $1200, or $23 a week he has increased his value to $30,000, and an increase of $5000 in valuation is very much worth while; especially as with it has come more power for further advance, and more courage to push on; a better point from which to move forward to the Big job you want 5 years ahead.

And what will win the raise? Training, experience, thinking it over,—never waiting.

PRACTICAL INSTRUCTIONS

Notwithstanding the fact that engineers are greatly benefited by what others have published in regard to what they have done in the line of experiment, there are many things in the operation of a plant that are, as it were, handed from one engineer to another by actual demonstration and word of mouth. In many cases the information thus gained saves time, increases the efficiency of the plant and could be used in other plants with equally good results if the kink were only known.

In this connection it is interesting to read the instructions given by Mr. Pierce, on another page of this issue, to Diesel engineers. Mr. Pierce takes the proper course in scattering the knowledge he has gained in operating Diesel engines and it is hoped that others who may have information "bottled up" will allow it to be of use to engineers in general.

NEWS NOTES

THE NELSON VALVE CO. has established a branch office at 415 San Pedro St., Los Angeles, Cal., where the W. H. Gilbert Sales Co. will act as direct representative for the state of California.

THE AMERICAN DISTRICT STEAM CO. of North Tonawanda, N. Y., announces the opening of its new Pacific Coast Offices, in the Hoge Building, Seattle, Wash., in charge of Eugene L. Barnes as District Manager.

HARRY B. ALLER, formerly with Manning, Maxwell & Moore, and who has for some time past been out of the steam field and in another line of machinery, has accepted a position with the Ashton Valve Co., and is now representing them in the Chicago district, with headquarters at 174 North Market St., Chicago.

THE NATIONAL ASSOCIATION of Manufacturers will meet in Detroit May 19 to 21, with headquarters at the Hotel Pontchartrain. There will be addresses and committee reports on Accident Prevention, Workmen's Compensation Laws, Fire Prevention, Patent Reform, Currency in Banking and other topics of importance to manufacturing interests.

CHAMBERLAIN & HOWELL, consulting engineers, Chicago, have made arrangements for increased working space, having removed their offices from 1522 Marquette Bldg., where they have been located for the past 3 yr., to suite 1710 Marquette Bldg., the new quarters affording greatly increased facilities.

THE NEW ENGLAND SOCIETY of Superintending Engineers held its regular monthy meeting and dinner on the evening of April 26 at the American House, Boston. A number of prominent engineers were admitted to membership and a very interesting talk was given by F. L. Fairbanks on the construction of boilers, after which there was a general discussion of the subject. President George W. Walsh presided.

C. WADSWORTH has established an office at 961-3 Woodward Ave., Detroit, Mich., with the intention of representing manufacturers of contractors' machinery and materials of construction, making more or less of a specialty of municipal equipment and supplies.

Along with sales representation it is purposed to render whatever engineering service may at times be necessary to insure proper installation and operation of the apparatus sold.

A LETTER FROM the Platt Iron Works Co., of Dayton, Ohio, states that its plant has been gotten in regular operation and the company, like all Dayton institutions, wishes to stand on its own strength and integrity. The best assistance that is asked by the Dayton firms is that they have a large volume of business, so that they may be able to keep full forces at work and to send out orders quickly.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for hydro-electrical engineer, for men only, on May 19, 1913. Applicants must have reached their 25th but not their 45th birthday on the date of the examination, which is open to all men who are citizens of or owe allegiance to the United States and who meet the requirements; they should at once apply for Form 304 and special form to the United States Civil Service Commission, Washington, D. C., or the Secretary of the Board of Examiners, at principal cities of the country.

YALE & TOWNE MANUFACTURING CO. has removed its general offices in New York City from 9 Murray St. to 9 East 40th St. The new location was selected after thorough investigation, as that best suited for the convenience of customers, and comprises a plot 50 by 100 ft., occupied by a 12-story building. On the ground floor is a series of exhibit rooms for the

display of the Yale & Towne products. The city sales room is in the basement, with a large stock room adjoining, and on the other floors are offices and department headquarters required for the company's business.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for logging engineer, for men only, on May 19, 1913. Applicants must have reached their 30th but not their 55th birthday on the date of the examination, which is open to all men who are citizens of or owe allegiance to the United States and who meet the requirements; they should at once apply for Form 1312 to the United States Civil Service Commission, Washington, D. C., or the Secretary of the Board of Examiners at principal cities of the country.

POLITNESS APPEARS to have been invented to enable people who would naturally fall out, to live together in peace.

NO GOOD THING is failure and no evil thing success.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

SYNCHRONOUS MOTORS FOR DRIVING COMPRESSORS

THE use of synchronous motors for driving compressors is comparatively new practice. A few years ago the synchronous motor was not considered well adapted for this service but recent improvements in the design of these motors have entirely changed this view. Today synchronous motor drive is used for many compressors in various

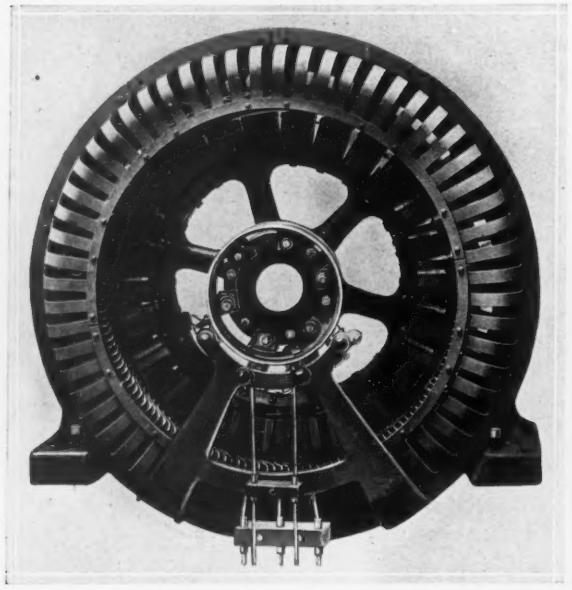


FIG. 1. WESTINGHOUSE SYNCHRONOUS MOTOR

parts of the country, and it has proved so efficient and reliable that the fact that this type of drive is the most satisfactory for this service can be considered established.

A typical example of this kind of utilization is furnished by the compressors at the Wickwire Mining Company's mines at Iron River, Mich. There are 2 compressors on this property, each driven by a Westinghouse self-starting synchronous motor. Both compressors are of Ingersoll-Rand make; one delivers 1352 cu. ft. of free air per minute at 200 r.p.m. and is driven by a 220-hp. motor, and the other delivers 995 cu. ft. of air at 225 r.p.m. and is driven by a 175-hp. motor. These compressors have been in operation over a year and have proven satisfactory.

As compared with other forms of drive for large compressors, synchronous motors possess a number of advantages. In the first place, the first cost of a synchronous motor compares favorably with that of other types of motors or engines. The motor is especially adapted for direct connection, so that it costs less to install and takes up minimum floor space. The elimination of belts also decreases the maintenance expense.

The reliability of these motors in this service is proven beyond question. There are a number of installations which have been giving perfect satisfaction for a long time. A notable instance is that of the Anaconda mines where a total of 7200 hp. of Westinghouse synchronous motors have been driving compressors for nearly 4 yr. without a hitch, in spite of variable operating conditions.

One of the chief objections to the old type of synchronous motors was the fact that it required some auxiliary starting device, but this difficulty has been eliminated. The synchronous motor is self-starting and self-synchronizing.

Another advantage of the synchronous motor is its ability to operate at 100 per cent power factor, which tends to improve the operation of generators and to increase the capacity of transformers and trans-

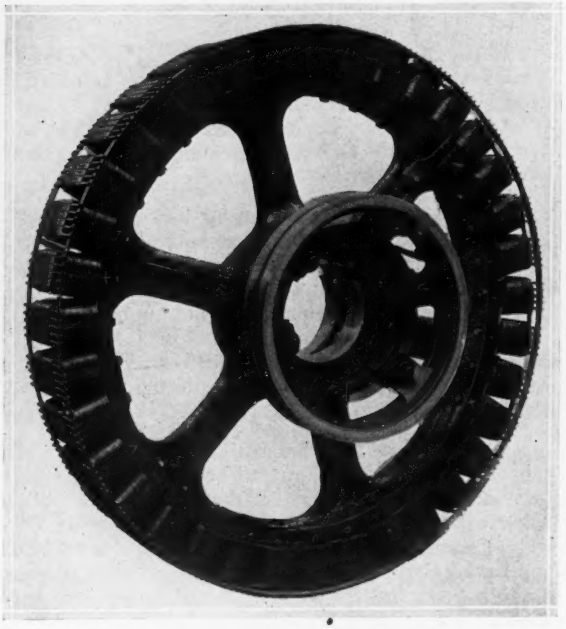


FIG. 2. ROTOR OF WESTINGHOUSE SELF STARTING SYNCHRONOUS MOTOR

mission lines. If desired, these motors can be arranged to raise the power factor of the entire circuit by being supplied with excess capacity and used as synchronous condensers; thus greatly increasing the operating efficiency of the generating and transmission system.

The synchronous motors used at Wickwire represent the most modern design. They are characterized by great strength and simplicity of construction,

as the illustrations show. The stator is supported by a heavy cast-iron frame, and the coils are form wound and so arranged that they can be easily removed and replaced if the necessity ever arises. The rotor consists of a cast-iron spider which carries the field poles. The windings are so arranged that they receive ample ventilation, and each field coil can be easily removed. An interesting feature of the rotor is the squirrel cage winding that encircles the field poles. This winding makes the motor self-starting and also eliminates "hunting," or surging, which was one of the disadvantages of the early type of synchronous motors.

The Wickwire mine is operated from 6000-volt, 60-cycle, 3-phase power supplied by the Peninsular Power Company. This voltage is stepped down to 2200 volts for the synchronous motors, and 220 volts for the motors for driving pumps and other apparatus.

AN IMPROVED GATE VALVE

THESE valves, which have had extensive use, are made of various materials, including brass, iron-body brass mounted, puddled semi-steel, and cast steel. They are made in various metals for different pressures, medium brass valves being intended for pressures up to 125 lb. in sizes 2 to 8 in. and for 100 lb., in sizes 9 to 12 in.; the heavy brass will stand 250 lb. pressure. In the iron body brass mounted, there are 4 weights, a standard pattern being intended for 125 lb. pressure, in sizes from 2 to 8 in., and 100 lb. in sizes 10 to 24 in.; a medium weight designed for 125 lb.; a heavy for 175 lb., and an extra heavy for 250 lb.

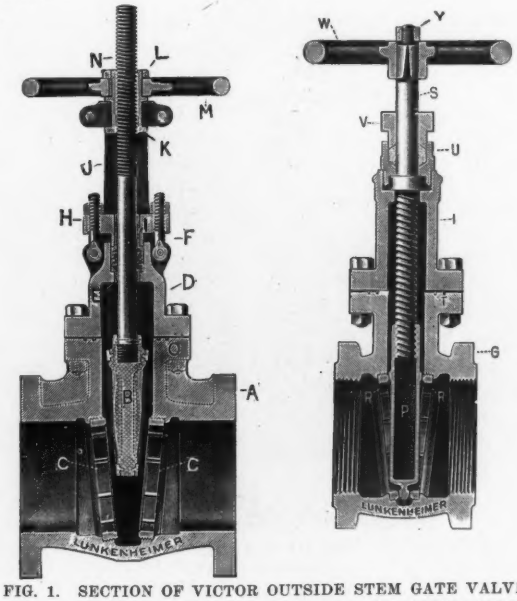


FIG. 1. SECTION OF VICTOR OUTSIDE STEM GATE VALVE
FIG. 2. VICTOR GATE VALVE WITH STATIONARY STEM

For high pressure and superheated steam, the puddled semi-steel is used, in sizes from 1½ to 16 in. inclusive, and carries steam for working pressures up to 250 lb. For extremely high conditions of pressure and superheat, the cast steel is used in 2 combinations, one being intended for pressures up to 300 lb., and the other up to 350 lb.

As shown in Figs. 1 and 2, the valve is made in 2 forms, one with stationary stem and the other with outside screw and yoke. In both forms, seat rings as well as wedge disc, can be renewed when worn, that portion of the valve body which receives the seat rings being threaded to the correct angle of taper of the valve disc, so that the rings are fitted and faced off straight, and when screwed in place, will fit accurately to the disc taper. Up to 6 in., the discs are made entirely of bronze, and above that, of iron with bronze seat trimmings. In the larger sizes, the rings are forced on the disc, a flange on the rings being flared out in a groove cut at an angle in the iron disc. This method of securing the bronze rings to the disc avoids danger of the rings becoming loose or dropping off. The valves are double-seated and will take the pressure from either side.

Either pattern of valve can be packed under pressure when wide open. The stuffing box in a stationary stem valve, is of bronze, tightly screwed into the hub, and for the outside screw type, both the gland and stuffing box are lined with bronze bushings which form a perfect bearing surface for the stem. Discs are accurately guided in the bodies, and thus relieved of all side strains.

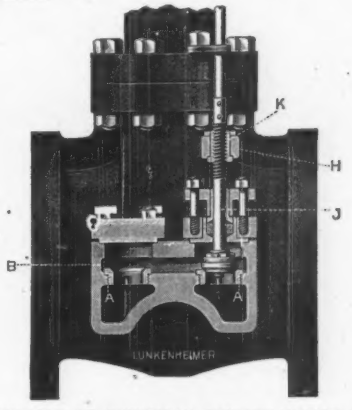


FIG. 3. DETAILS OF INTEGRAL BYPASS VALVE USED ON VICTOR GATES

In making the joint between the body and the hub, grooves are cut in the top surface of the valve body, in which are placed seamless copper gaskets, making a joint which will not leak. Yokes and hubs are rigidly held into the body by large steel bolts having both heads and nuts bearing on spot-faced surfaces, thus insuring an even bearing.

In Fig. 3 are shown the details of the bypass which may be used on these valves, and which is cast integral with the valve body. This additional metal strengthens the valve body, and as it is part of the body it is not affected by expansion and contraction. The bypass valve fittings are bolted to the body by a number of steel studs. The stuffing box of bronze has a flange on the bottom which prevents the iron flange above from touching the iron body, so that the surfaces cannot corrode. The bypass also has outside screw and yoke which increases durability and makes it possible to renew them if the surfaces become worn. The discs in the bypass valve are so constructed that they can be reground when worn, and the areas are large enough to admit steam around the disc to equalize pressure on both sides quickly. These bypass valves are accessible at all times and by their use not only are the valves easier to operate, but durability of the main valves is increased. These valves, which are known by the trade name of Victor, are made by the Lunkenheimer Co., of Cincinnati, O., which company holds the patent on this improved form of bypass.

A COMPACT CONDENSING PLANT

IN the photographs reproduced herewith is shown a compact surface condensing plant, consisting of a surface condenser with turbine driven air, circulating and hot well pumps, recently built by the C. H. Wheeler Mfg. Co. of Philadelphia, Pa., to operate in conjunction with a 3500-kw. Westinghouse-Parsons turbo generator. The condenser contains 13,500 sq. ft. of tube surface made up of No. 18 B. W. G. seamless drawn brass tubes 18 ft. 2 in. long, both ends secured by ferrules into rolled Muntz metal tube sheets. It will be seen that the condenser is of the 2-pass type and arranged for full counter-current operation.

FIG. 1. CONDENSER FOR 3500-KW. TURBO GENERATOR

Exhaust steam enters at the bottom of the shell through a 48-in. exhaust inlet and passes upward on the outside of the tubes toward the air pump suction, which is at the highest point of the shell.

Circulating water openings are 24 in. in diameter, and the water passes downwards, entering at the top and travelling first along the top bank of tubes, then reversing and passing through the middle bank of

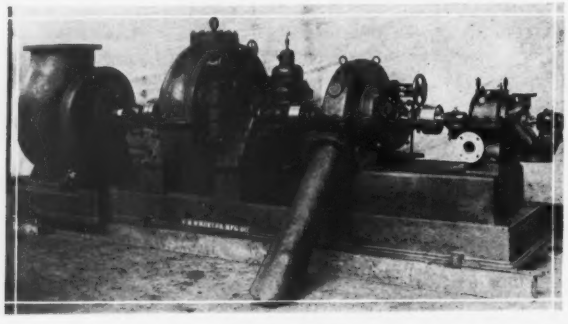


FIG. 2. TURBINE-DRIVEN CENTRIFUGAL PUMP UNIT FOR CONDENSER SERVICE

tubes and then through the bottom bank of tubes and out at the bottom opening on the water box. At the under side of the condenser shell is provided a hot well chamber, and the condensed steam collects in this chamber and is removed by the hot well pump.

Figure 2 shows the pump combination and it is in this arrangement of the air, circulating and hot well pumps that the special features of the equipment are principally involved. The unit consists of a 20-in. high-speed, low-head centrifugal entrainment type air pump, and a 2-stage centrifugal hot well pump, the entire combination being driven by a Terry steam turbine. This latter is a special type with the shaft extended at both ends, driving the circulating pump from one end and the centrifugal air and hot well pumps from the other end of the shaft.

The entire combination is mounted upon a substantial cast-iron sub-base, which is provided with a lip all around to collect drips from the pump. The driving turbine is of 125 brake hp. The condensing equipment is guaranteed to condense 60,000 lb. of steam an hour, and to produce a vacuum of 2.25 in. absolute; that is, 27.75 in. referred to 30-in. barometer, with circulating water available at 85 deg. F. This is equivalent, with a normal water temperature of 70 deg., to a vacuum of a little better than 1.5-in. absolute; that is, 28.5 in. referred to 30-in. barometer.

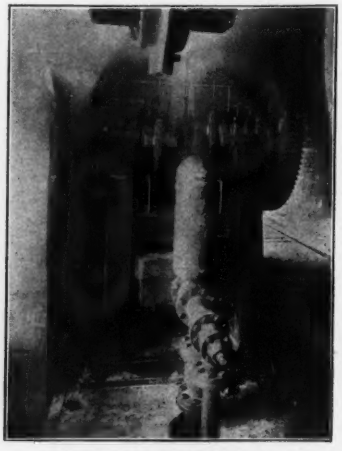
The compactness of the entire unit renders it particularly desirable for the location where it will be installed and was designed to fit into the available space.

The normal speed of the combined pump unit is 1450 r.p.m., but this can be varied by adjusting the governor of the turbine to suit varying water temperatures and take care of heavy overloads by increasing the quantity of water passing through the condenser, thus making an extremely flexible arrangement.

LUBRICATING THRUST BEARINGS

Oil at 250 Lb. Pressure for Generator Bearings in the World's Largest Hydroelectric Plant

THE power plant of the Mississippi River Power Co. now in course of construction at Keokuk, Iowa, will ultimately contain 30 generating units, with a rated capacity of 10,000 hp. each, at the normal head of 32 ft. At the maximum head of 39 ft. the output will be approximately 14,000 hp. each.



TRIPLEX PUMP USED FOR MAINTAINING 250-LB. OIL PRESSURE ON BEARINGS

Water wheels are the single runner type and run at 57.7 r.p.m. They are direct connected to vertical, slow-speed generators. The turbines are the largest ever built and the plant is the first important one ever built with slow speed units.

Thrust bearings are a combination roller and oil pressure bearing. As the total weight of the unit which each of these bearings has to support is 275 tons, the importance of the oil supply is very apparent. The oil is pumped to the bearings by means of triplex pressure pumps made by The Goulds Mfg. Co.,

Seneca Falls, N. Y. It is supplied at a pressure of 250 lb. per square inch, which is sufficient to lift the unit so that it floats on the oil and relieves the rollers of the load.

The pumps have 6½-in. cylinders and 8-in. stroke. They are operated by chain drive from a line shafting.

CORRECTION NOTE

OUR attention is called to an error in the article by John Dick, page 405 of the April 15 issue. In the second column of that page, near the bottom of the second paragraph, the lines should read: "The cut shows a checker work baffle wall at the entrance of the furnace, the purpose of which is to retard the passage of the gases, producing a reverberatory effect, and which brings the gases into direct contact with the heated surfaces of the fire brick, and giving more perfect combustion, without interfering with the draft."

By one of the mysterious happenings, which is always attributed to the "printer's devil," a line from an entirely different article got substituted for the next to the last line of this paragraph, spoiling the sense of the statement.

NEW POWER PLANTS

THE MOUNT PLEASANT (Tex.) Light & Power Co.'s plans for improvements call for a 50-ton ice plant in place of the 10-ton plant heretofore in use. The plant is one of the number owned by the Albert Emanuel interests of Dayton, Ohio.

THE CONTRACT FOR THE ERECTION of an extensive addition to the Manchester St. power house for the Rhode Island Co. has been awarded. An addition will be made on the north side 35 ft. wide and 160 ft. long, to contain new electrical apparatus and an addition on the west end 72 ft. wide and 150 ft. long, where a battery of boilers and 2 new turbines, to cost $340,000 each, will be installed.

The new turbines, it is expected, will give the company a surplus of power which may be transmitted to some of the lines in Connecticut. It is estimated that the improvements will cost $750,000.

THE HIGHLAND POWER CO., composed of Colorado, New York and Philadelphia capitalists, has been formed to construct a plant and enter into competition with the Central Colorado Power Co. in the lighting of Black Hawk, Central City and the tungsten and gold mines of Boulder county.

Contracts will be let for the installation of a generating plant of a capacity of 3000 hp. and for transmission lines through Boulder and Gilpin counties, and it is said that the plant and lines will be in operation inside of 6 months. The power plant is planned to be built at the town of Hesse, in Boulder County.

IF THE PROPOSITION at this time under serious contemplation is carried to a successful termination, one of the best power and reservoir projects in the southwest will be financed by Muskogee, (Okla.) and Texas capitalists. It is being proposed to build a dam 150 ft. high and 350 ft. long across Mountain Fork, in McCurtain County, which will develop, it is said, 2000 or more commercial horsepower and likewise create a great reservoir supply of fresh water which will be available for cities in north Texas and south Oklahoma in case of a drouth.

CONSTRUCTION WORK COSTING $1,250,000, most of it in the San Joaquin valley or adjacent mountains, is to be performed at once by the San Joaquin Light & Power Co.

The steam plant of the company at Bakersfield, Cal., is to be doubled in capacity.

The plant at Santa Maria, one of the new ones acquired by the company within the past several months, will likewise be enlarged.

Work is to be rushed on plant No. 2 at North Fork, and also on the one at Tulare River.

The plant in the Kern River canyon will be doubled in size.

The total expense of all this work, as stated, will amount to over $1,250,000, and will be aside from the expense of making extensions to the power lines, work upon which will be pushed at greater speed than ever.

The work of improvement, under the agreement reached, must all be finished before Jan. 1, 1914.

IMPROVEMENTS INVOLVING the expenditure of more than $200,000 in the lighting department alone will be made by the Pensacola Electric Co. during the summer, according to the manager. The company has decided on a number of improvements in Pensacola during the present year, and it is expected that the expenditures in the way of extensions and improvements will total approximately $400,000. The plan includes the erection of a modern concrete car barn, and the installation of a modern turbo generator in the power station. It is expected that, by the first of November, the company will be able to furnish 2800 kw. for lighting purposes.

The addition to the power station will necessitate the erection of an extension to the plant. This will be of concrete foundation and steel frame construction. It is expected that work on this addition will commence during the early summer.

PLANS FOR THE CONSTRUCTION of a modern power plant, driven entirely by steam, are being prepared by the officials of the Penn Central Light and Power Co., and work on the construction of the power plant will be started soon, probably somewhere in Cambria Co., Pa. There has been a rumor that it was planned to abandon the present plant of the company at Warrior Ridge, but General Superintendent E. B. Greene, states that this rumor is entirely false and that there was no plan thought of, which would include the abandonment of this plant.

Mr. Greene states that the new plant will have a capacity, when is is first operated, of at least 2100 kw., while the present equipment has a capacity of 6500 kw.

It will consist of steam turbines, and there will be no provision made for anything but steam power to operate the plant.

MAYOR IRVING OF BINGHAMPTON (N. Y.) recently signed the ordinance directing the Commissioner of Public Works to acquire land on Noyes' Island for a site of the proposed new municipal lighting plant. The Board of Estimate and Apportionment met and approved the ordinance and Commissioner of Public Works Darling has started negotiations on behalf of the city for the purchase of the site.

The mayor was upon the scene when the water was at its height and found nothing to show that the site was in any way dangerous for the building of the municipal lighting plant. He asserts that reports that the proposed site was under water are false, the site being on the same level as the other factory sites on Noyes' Island, none of which were at any time threatened by the high waters, nor could they be threatened even should the water rise to the 1902 record.

AT THE ANNUAL ELECTION the city of Reynolds, N. D., has voted in favor of installing an electric light plant.

THE PROPOSITION TO BUILD a municipal electric light plant at Augusta, Kan., recently carried with a substantial majority.

THE CITY ENGINEER of Cedar Falls, Ia., is preparing plans for the erection of a city lighting plant for the Citizens Gas and Electric Co.

ROSEAU, MINN., HAS PURCHASED property to be used as the site of the waterworks and electric light plant which will be erected this summer.

AT GARDEN CITY, KAS., an ordinance authorizing the sale of bonds to the amount of $40,000 for the erection of a municipal lighting plant was passed by the city council last week.

BOOK REVIEW

THE FIRST VOLUME of Proceedings of the Efficiency Society is now ready for distribution, and contains the transactions for 1912, giving proceedings of the meetings and papers submitted at those meetings for the year. The book is furnished without charge to members of the Society, and to non-members the price is $5.00.

THE BUREAU OF MINES has copies of the following publications for free distribution, but can not give more than one copy of the same bulletin to one person.

Bulletin 48. Selection of explosives used in engineering and mining operations, by Clarence Hall and S. P. Howell. 1913. 50 pp.

Bulletin 55. The commercial trend of the gas producer in the United States, by R. H. Fernald. 1913. 92 pp.

Bulletin 62. National Mine-Rescue and First-Aid Conference, Pittsburgh, Pa., September 23-26, 1912, by H. M. Wilson. 1913. 74 pp.

Technical Paper 38. Wastes in the production and utilization of natural gas, and means for their prevention, by Ralph Arnold and F. G. Clapp. 1913. 29 pp.

Technical Paper 48. Coal-mine accidents in the United States, 1896-1912, with monthly statistics for 1912, compiled by F. W. Horton. 1913. 72 pp.

Requests for all papers can not be granted without satisfactory reason. In asking for publications please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

HOW TO READ A DRAWING; by Vincent C. Getty, 64 pages, 6 by 9 in., fully illustrated, in cloth binding, price $1.

Many books have been published for the student who wants to learn how to make a drawing, but this is the first which the writer has seen whose purpose is to enable the student to understand a drawing or a blueprint, if he has not had training in making drawings. A drawing is entirely understandable, even if one has not studied how to make it, just the same as a picture in a book may be seen and understood, even though the reader is not familiar with the process of making the illustration. The book deals, first, with the method of representing objects, then explains the lines used in projection drawing, the views needed to make the outline and construction of an object clear, next shows the most commonly used structural shapes, explains the scales used in drawing, and shows structural details such as bolts, nuts, rivets, screws, etc. The simple views in mechanical drawings are then shown, and there follows an explanation of complete drawings of gearing, a storage tank, a valve and architectural views. By using this book and practicing on reading construction of drawings the reader will gain the knowledge that it is intended to give, namely, how to read a drawing.

CATALOG NOTES

COLUMBIA RECORDING THERMOMETERS with rigid, straight or angle connection and flexible steel capillary connecting tubing, are described in a circular from the Schaeffer & Budenberg Mfg. Co., 481 DeKalb Ave., Brooklyn, N. Y.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., has just published a new booklet entitled Graphite for the Boiler. This booklet deals with no new discovery, for graphite has been sold to remove scale from boilers for many years. It simply states in as few words as possible why and how Dixon's Boiler Graphite does its work.

THE GENERAL ELECTRIC CO. has just issued Bulletin No. A-4102, devoted to sewing machine motors—for family size machines. This bulletin supersedes the company's previous bulletin on this subject, and contains illustrations and descriptions of the new design of motor perfected by the General Electric Co.

Bulletin No. A-4110, supersedes the company's previous bulletin on the subject of cloth pinions and contains additional data relative to tooth dimensions and instructions for the selection of pinions.

"CLEANING LOCOMOTIVE Arch Tubes" is the title of Bulletin W, recently issued by the Lagonda Mfg. Co., of Springfield, Ohio. The pamphlet points out how, due to the fact that the tubes now used by many large railroads for supporting arches in the fire box are subjected to enormously high temperatures and the rate of water evaporation in them is high, scale deposits form quickly. A special type of tube cleaner for use in locomotive arch tubes is described. Copies of this publication may be had by addressing the company as above.

THE INGERSOLL-RAND CO., 11 Broadway, New York City, has issued a 20-page, 6 by 9-in. illustrated bulletin descriptive of its Imperial "XB" duplex power driven air compressors, showing a table of sizes and capacities. These machines are suitable for mine, tunnel, quarry and contract plants, shop and foundry equipments; air power plants for railway repair shops and for switch and signal service; air lift, "return air" displacement pumping systems, and for general industrial applications of compressed air. Among the many recognized advantages of duplex construction in power driven air compressors are: a balanced construction with quartered cranks effecting an equalization of efforts; easier duty on the belt; the reduction of structural stresses by this balanced construction; the ease with which the air cylinders can be compounded, with all the attendant economies and without any increase in the number of working parts. The air intake valves are of the "Imperial Corliss" type operated from eccentrics on the main shaft; the discharge valves are of the "Imperial Direct Lift" pattern.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve

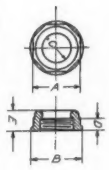
These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

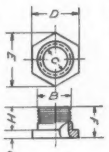
PRACTICAL ENGINEER

DIMENSIONS OF MALLEABLE IRON CONDUIT BUSHINGS

All Dimensions are in Inches

NOMINAL SIZE OF CONDUIT	A	B	C	D	E	THREADS PER INCH	B	C	D	E	F	G	H
⅛	⅜	⅜	⅜	⅜	⅜	27	.37	.56	⅝	⅜	⅜	⅛	⅛
¼	½	½	½	½	½	18	.49	.75	¾	½	½	¼	¼
⅜	⅝	⅝	⅝	⅝	⅝	18	.62	.93	⅞	⅝	⅝	¼	⅜
½	¾	¾	¾	¾	¾	14	.82	1.04	1	¾	¾	⅜	½
¾	⅞	⅞	⅞	⅞	⅞	14	.82	1.04	1	¾	¾	⅜	½
1	1	1	1	1	1	11½	1.02	1.29	1	¾	¾	⅜	⅝
1¼	1⅜	1⅜	1⅜	1⅜	1⅜	11½	1.02	1.29	1	¾	¾	⅜	⅝
1½	1⅝	1⅝	1⅝	1⅝	1⅝	11½	1.02	1.29	1	¾	¾	⅜	⅝
2	2	2	2	2	2	11½	1.02	1.29	1	¾	¾	⅜	⅝
2½	2⅜	2⅜	2⅜	2⅜	2⅜	8	1.29	1.63	1¼	1	1	½	⅞
3	2⅞	2⅞	2⅞	2⅞	2⅞	8	1.29	1.63	1¼	1	1	½	⅞
3½	3⅜	3⅜	3⅜	3⅜	3⅜	8	1.29	1.63	1¼	1	1	½	⅞
4	3⅞	3⅞	3⅞	3⅞	3⅞	8	1.29	1.63	1¼	1	1	½	⅞
4½	4⅜	4⅜	4⅜	4⅜	4⅜	8	1.29	1.63	1¼	1	1	½	⅞
5	4⅞	4⅞	4⅞	4⅞	4⅞	8	1.29	1.63	1¼	1	1	½	⅞
6	5⅞	5⅞	5⅞	5⅞	5⅞	8	1.29	1.63	1¼	1	1	½	⅞





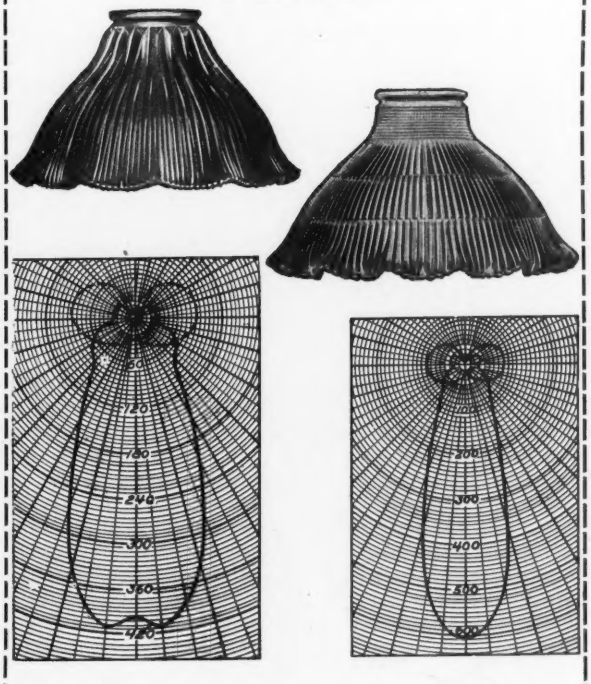
DIMENSIONS OF CONDUIT NIPPLES

PRACTICAL ENGINEER

DUST SEPARATORS.

Diameter of fan outlet in inches.	Area of fan outlet in square inches.	Openings in Separator. Size of inlet in inches.	Openings in Separator. Area of inlet in square inches.	Openings in Separator. Diameter of air outlet in inches.	Openings in Separator. Area of air outlet in square inches.	Openings in Separator. Diameter of dust outlet in inches.	Dimensions of Separator. Outside diameter in inches.	Dimensions of Separator. Height of cylinder in inches.	Dimensions of Separator. Length of cone in inches.	Shipping weight. Lbs.
5	20	2½ x 9	23	5½	56	3	29½	14	26½	70
6	28	3 x 10½	32	10	78	4	35½	15½	32½	101
7	38									
8	or	3½ x 13	47	13	132	6	41½	18½	37½	140
9	50									
10	63	4½ x 16	72	15	176	6	47½	21	43½	173
11	75	5 x 18	90	17	227	6	53½	23	50	245
12	95									
13	or	5½ x 21	115	20	314	10	59½	26	56	315
14	113									
15	133									
16	or	6½ x 24	156	23½	433	10	65½	29	61½	396
17	154									
18	177	7 x 27	189	26	531	10	71½	32	67½	490
19	201									
20	or	8 x 30	240	28	615	10	77½	35	73½	575
21	227									
22	254	8½ x 33	278	31	754	10	83½	38	77½	715
23	283									
24	or	9 x 35	315	33	855	10	89½	41	82½	875
25	314									
26	346	9 x 40	360	36	1,017	10	93½	48	85½	930
27	380	10 x 41	410	39	1,194	10	97½	47	89	1,000
28	415									
29	or	10½ x 43	451	41	1,320	11	101½	49	93	1,095
30	452									
31	491	11 x 45	495	44	1,520	11	105½	51	97	1,455
32	531	11 x 48	528	46	1,662	12	109½	54	99½	1,600
33	572	11 x 51	561	49	1,885	12	113½	57	103½	1,700
34	631	11½ x 54	621	52	2,123	12	117½	60	109½	1,855
35	660	12 x 57	684	55	2,375	12	121½	63	111½	2,035
36	707	12 x 60	720	58	2,642	12	125½	66	115½	2,155
37	754									
38	or	12½ x 63	807	61	2,922	13	129½	69	118½	2,250
39	804									
40	855	13 x 66	858	64	3,217	13	133½	72	122½	2,420
41	908	13½ x 69	932	67	3,525	13	137½	75	126½	2,555
42	962	14 x 72	1,008	70	3,848	14	141½	78	129½	2,745
43	1,017									
44	or	14½ x 75	1,087	73	4,185	14	145½	81	133½	2,900
45	1,075									
46	1,134	15 x 78	1,170	76	4,536	14	149½	84	137½	3,065
47	1,194									
48	or	15½ x 81	1,255	79	4,901	14	153½	87	141½	3,235
49	1,256									
50	1,330	16 x 84	1,344	82	5,281	14	157½	90	145½	3,395

PRACTICAL ENGINEER



Focusing Concentrating

FOCUSING TYPE HOLOPHANE LAMP SHADE AND PHOTOMETRIC CURVES OF 100-WATT LAMP WITH AND WITHOUT SHADE

CONCENTRATING TYPE HOLOPHANE LAMP SHADE AND PHOTO METRIC CURVES OF 100-WATT LAMP WITH AND WITHOUT SHADE

PRACTICAL ENGINEER

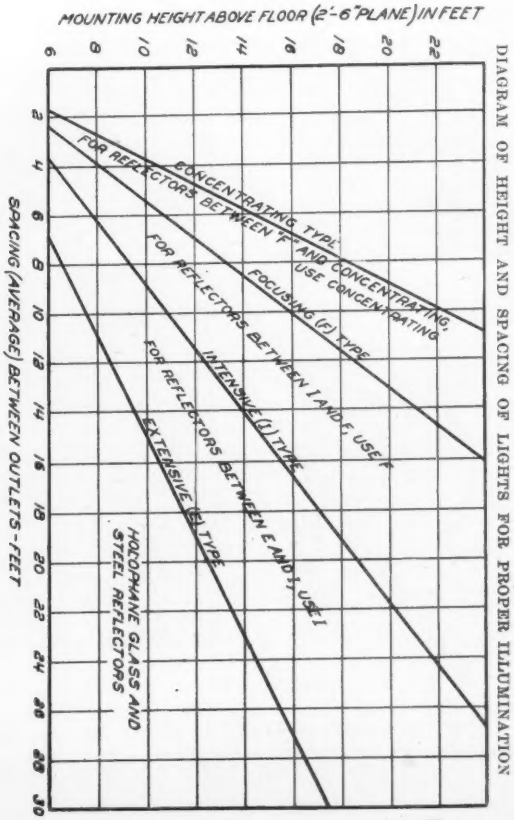
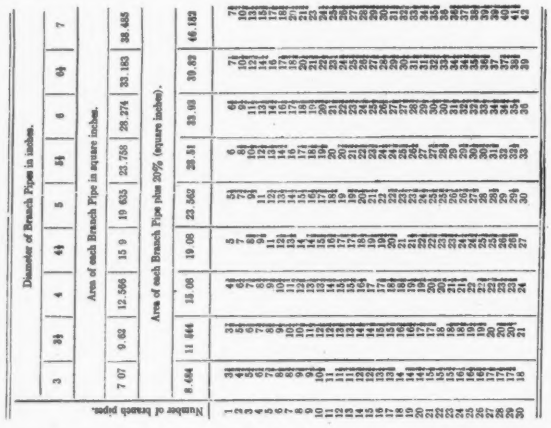

MOUNTING HEIGHT ABOVE FLOOR (2'-6" PLANE) IN FEET
6 8 10 12 14 16 18 20 22
SPACING (AVERAGE) BETWEEN OUTLETS - FEET
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
FOR REFLECTORS BETWEEN "F" AND CONCENTRATING, USE CONCENTRATING
FOCUSING (F) TYPE
FOR REFLECTORS BETWEEN I AND F, USE F
INTENSIVE (I) TYPE
FOR REFLECTORS BETWEEN E AND I, USE I
EXTENSIVE (E) TYPE
HOLOPHANE GLASS AND STEEL REFLECTORS

DIAGRAM OF HEIGHT AND SPACING OF LIGHTS FOR PROPER ILLUMINATION

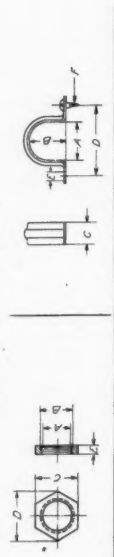
MINIMUM SIZES OF BRANCH PIPES FOR GRINDING, POLISHING AND BUFFING WHEELS

Diameter of Wheels. Inches	Emery and Other Grinding Wheels		Buffing, Polishing or Rag Wheels	
	Maxi'm Grinding Surface sq. in.	Mini'm Diam. of Branch Pipe in in.	Maxi'm Grinding Surface sq. in.	Mini'm Diam of Branch Pipes in in.
6 or less, not over 1 in. thick	19	3	19	3½
7 to 9 inc., not over 1½ in. thick	43	3½	.....	.....
7 to 12 inc., not over 1½ in. thick	.....	.....	57	4
10 to 16 inc., not over 2 in. thick	101	4	.....	.....
13 to 16 inc., not over 2 in. thick	.....	.....	101	4½
17 to 19 inc., not over 3 in. thick	180	4½	.....	.....
17 to 20 inc., not over 3 in. thick	.....	.....	189	5
20 to 24 inc not over 4 in. thick	302	5	.....	.....
21 to 24 inc not over 4 in. thick	.....	.....	302	5½
25 to 30 inc., not over 5 in. thick	472	6	472	6½



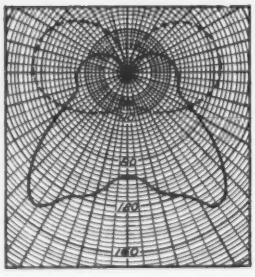
DIMENSIONS OF PUNCHED STEEL GALVANIZED IRON PIPE STRAPS CONDUIT LOCK NUTS

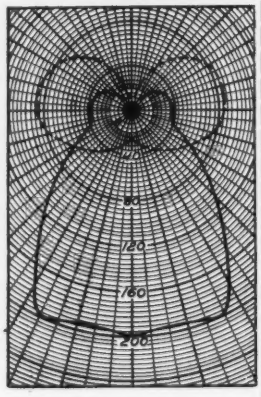
All Dimensions are in Inches



NOMINAL SIZE OF CONDUIT	THREADS PER INCH	A	B	C	D	E	A	B	C	D	E	SIZE OF WOOD SCREW TO USE	APPROXIMATE NUMBER PER POUND
¼	18	⅝	13/32	⅝	1⅛	⅜	.568	.539	1	1⅛	⅜	8 x ⅜	75
⅜	18	⅝	13/32	⅝	1⅛	⅜	.568	.539	1	1⅛	⅜	8 x ⅜	75
½	14	⅞	⅝	⅞	1⅜	½	.701	.665	1⅛	1⅜	½	8 x ¾	72
¾	14	⅞	⅝	⅞	1⅜	½	.701	.665	1⅛	1⅜	½	8 x ¾	72
1	11½	1	¾	1	1⅝	⅝	.911	1.025	1⅛	1⅝	⅝	10 x ¾	40
1¼	11½	1	¾	1	1⅝	⅝	.911	1.025	1⅛	1⅝	⅝	10 x ¾	40
1½	11½	1⅛	⅞	1⅛	1 13/16	⅝	1.144	1.283	1⅛	1 13/16	⅝	10 x ⅞	29
2	11½	1⅛	⅞	1⅛	1 13/16	⅝	1.144	1.283	1⅛	1 13/16	⅝	10 x ⅞	29
2½	8	1⅜	1	1⅜	2 5/16	¾	1.408	1.657	1⅜	2 5/16	¾	10 x 1	21
3	8	1⅜	1	1⅜	2 5/16	¾	1.727	1.866	1⅜	2 5/16	¾	10 x 1	21
3½	8	1⅜	1	1⅜	2 5/16	¾	2.223	2.339	1⅜	2 5/16	¾	10 x 1	21
4	8	1⅜	1	1⅜	2 5/16	¾	2.680	2.880	1⅜	2 5/16	¾	10 x 1	21
5	8	1⅜	1	1⅜	2 5/16	¾	3.241	3.441	1⅜	2 5/16	¾	10 x 1	21
6	8	1⅜	1	1⅜	2 5/16	¾	3.241	3.441	1⅜	2 5/16	¾	10 x 1	21

* THE 3 INCH LOCK NUT IS OCTAGONAL INSTEAD OF HEXAGONAL





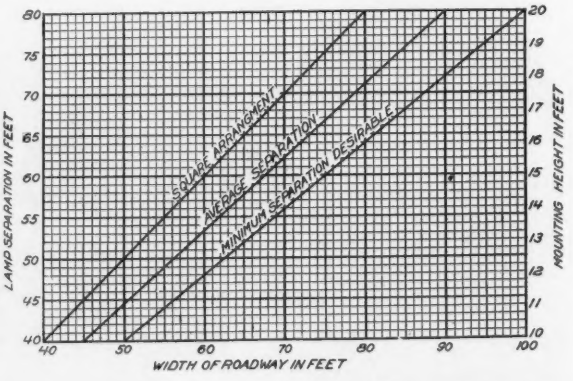
Extensive

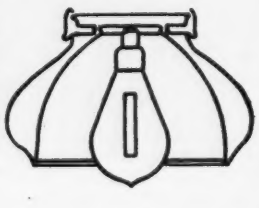
Intensive

EXTENSIVE TYPE HOLOPHANE LAMP SHADE AND PHOTOMETRIC CURVES OF 100-WATT LAMP WITH AND WITHOUT SHADE

INTENSIVE TYPE HOLOPHANE LAMP SHADE AND PHOTOMETRIC CURVES OF 100-WATT LAMP WITH AND WITHOUT SHADE

SPACING FOR STREET LIGHTS WITH HOLOPHANE REFLECTORS. OPPOSITE ARRANGEMENT





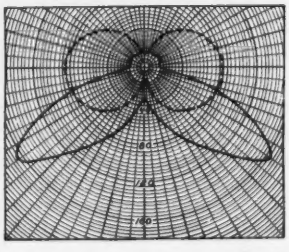


DIAGRAM OF HOLOPHANE STREET LIGHTING UNIT AND PHOTOMETRIC CURVES OF 100-WATT TUNGSTEN LAMP WITH AND WITHOUT REFLECTOR

THE OHIO BRASS CO., of Mansfield, O., has just issued a circular illustrating some of its valves.

BULLETIN NO. 114 from the Goulds Manufacturing Co., Seneca Falls, N. Y., contains 8 pages of description, illustrations and tables relating to Goulds' vertical, single stage, centrifugal pumps.

THE HYDRO-CATOR, a new liquid gage, is illustrated and its uses and method of operation are given in a circular from Sterling Gauge Co., 132 Larned St., E., Detroit, Mich.

ARGUTO OILLESS BEARINGS, made of wood which has been chemically treated, are discussed in a pamphlet from Arguto Oilless Bearing Co., Philadelphia, Pa.

PENNSYLVANIA PNEUMATIC CO.'S new bulletin shows Barr "unit-compound" air compressors in various types of steam, belt and electric drive. Copies may be had by addressing the company at Erie, Pa.

ENGINEERING DEPARTMENT of the National Electric Lamp Association, 4411 Hough Ave., Cleveland, O., has just issued Bulletin 11A, describing Mazda street series lamps and giving a list of other bulletins now available.

RELIANCE ADJUSTABLE SPEED motor of the armature shifting type is described as a direct-current motor that runs at any speed and develops a constant output over any range up to 1 to 10, requiring no electric controller. Illustrations are also given in Bulletin No. 1010 from Reliance Electric and Engineering Co., Cleveland, O.

"KEEP YOUR BOILERS Off the Scrap Heap" is the title of a folder on boiler cleansing chemicals manufactured by Thos. C. Warley & Co., 221 S. Front St., Philadelphia.

THE NEW CATALOG of Wm. B. Scaife & Sons Co., on gasoline storage outfits, gasoline tanks, garage tanks, pumps, etc., has recently been received. The outfits and tanks are suitable also for oils and other liquids.

"HOW TO MAKE Your Canvas Belts Do Best Work" is the title of a 12-page booklet published by the Cling-Surface Co., Buffalo, N. Y. The booklet is well illustrated and is full of technical arguments and data that should appeal to belt users.

A BOOKLET DESCRIPTIVE of the H. W. Johns-Manville Co.'s new flooring, called J-M (Mastic), is now ready for distribution, and can be had from the company, at its New York address, by anyone interested.

FOLDER NO. 6 of the historical series issued by Jefferson Union Co., Lexington, Mass., touches upon the character and achievements of Bolivar, the Washington of South America.

Illustrations and some details concerning Jefferson unions are given.

THE GENERAL ELECTRIC CO. has just issued Bulletin No. A-4084, devoted to centrifugal compressors, which supersedes a previous bulletin on this subject.

Bulletin A-4061, from the same company, describes electric arc headlights, and supersedes the company's previous bulletin on the subject.

BULLETIN NO. A4069, just issued by the General Electric Co., is devoted to the subject of portable and stationary air compressor sets, which supersedes the company's previous bulletin on this subject

FROM NASON MFG. CO., 71 Fulton St., New York, we have received folders describing Walworth cast-iron screwed fittings, Nason steam heater, water pressure regulator, etc.

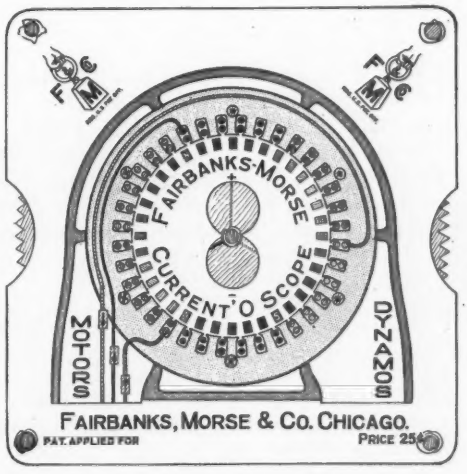
A CIRCULAR FROM James McCrea & Co., 558-560 Washington Blvd., Chicago, describes the Climax steam-joint clamp, the Emergency pipe clamp, the Skinner Valve-reseating tool and other devices.

AN INSTRUCTIVE BOOKLET describing the new line of Victor improved gate valves is issued by the Lunkenheimer Co., of Cincinnati, Ohio, who will be glad to send a copy to anyone interested.

THE INDUSTRIAL INSTRUMENT Co.'s Bulletin No. 73 contains 40 pages on thermometers and thermographs, with illustrations and specimen charts and scales. Copies may be obtained from the company at 50 Church St., New York, and Monadnock Bldg., Chicago.

TRADE NOTES

TO AID THE STUDENT in grasping an understanding of the relation of the current and magnetism in an induction motor, a mechanical illustration has been devised by Fairbanks, Morse & Co. The device, known as a current'o scope, is illustrated herewith and shows in a simple and correct manner how the revolving field is produced by the action of alternating currents in a 3-phase induction motor, by illustrating the varying strength of the current in each phase, its direction and the position of the shifting magnetic poles. To those interested in the action of an induction motor the current'o scope is an instructive device and may be secured from Fairbanks, Morse & Co., Indianapolis, Ind.



WHITLOCK COIL PIPE CO., of Hartford, Conn., is now represented in Chicago and surrounding territory by Adkins, Young & Allen Co., of 109 N. Canal St., Chicago. The Whitlock products include American feedwater heater, American Berryman, Whitlock open exhaust heater and purifier and the American hot water heater.

THE BAYER Steam Soot Blower Co., St. Louis, Mo., has about completed a new building adjoining its present plant which will more than double its shop capacity. With the increased facilities which the new shop will afford the company will be in a position to care promptly for a volume of business that has been constantly increasing.

Recently the capital stock of the company was increased to $100,000. New literature, covering a line of Soot Blowers for every type of boiler, will soon be ready for distribution.

IT WAS less than a year ago that The Clipper Belt Lacer Co., Grand Rapids, Mich., moved into a new and perfectly appointed factory, with facilities that seemed ample to provide for future business demands. Today a factory extension of 7500 sq. ft. is under construction and will soon be ready for occupancy. With the added shop capacity the company hopes to keep up with the ever increasing demand for Clipper Belt Lacing Machines.

IN ACCORDANCE WITH its policy adopted a number of years ago, the Graton & Knight Manufacturing Co., of Worcester, Mass., which makes oak leather belt, recently held a salesmen's convention at its main factory in Worcester. This convention was attended by the company's salesmen from all parts of the country, and the various sessions were devoted to an inspection of the factory, to a study of methods of manufacture, as well as to the sale and application of the company's products. At the conclusion of the convention a banquet was served at which more than 100 officers, salesmen and other employes were present. A feature of this year's meeting which was especially inspiring to those in attendance was the presence of Henry C. Graton, founder of the business. To a very large extent the phenomenal growth of the business from a small belt shop in 1851 to a plant that is one of the largest of its kind in the world is to be attributed to the sagacity and wisdom of Mr. Graton and his early associates, and to the persistent adherence of the firm to the policy early adopted of endeavoring to meet the steadily increasing demands for the most serviceable leather belting.

FORTY-FIVE YEARS ago, in 1868, the firm of Adam Cook's Sons was founded in Albany, N. Y., as the Albany Lubricating Compound and Cup Co. by Adam Cook, who attacked the problem of lubrication in an entirely original manner, and finally produced a compound that was what he wanted and which he called Albany Lubricating Compound; but the engineers of this country soon called it Albany Grease, and it has ever since been known by that name.

The first small plant in Albany was outgrown in 4 years and in 1872 larger quarters were secured along the river front at 231 West St., New York City. Here future growth in 1881, forced a move to still larger quarters at 313 West St., where additions were continually made to meet the growing demands until it was finally decided that it would be better to concentrate the different departments and plan the manufacturing system according to modern principles and to bring under one roof and in close relation, all of the various departments of the business. After 30 yr. the West St. plant was abandoned and the present modern commodious plant at 708-710 Washington St. was placed in service.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.
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No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500.

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Positions Wanted

POSITION WANTED—AS ENGINEER or switch-board operator in large station. Nine years experience, engines, boilers, turbines. A. & D. C. currents. Well up in modern plant methods. Total abstainer. N. E. C., No. 8 Arlington Ave., Morgantown, W. Va. 5-15-1

POSITION WANTED—Electrical Engineer wants to locate with some reliable isolated plant in Public Service plant, nine years' experience at estimating, constructing and mining plants. Can give best of references as to ability and habits. Chas. Thomas, Jr., Box 464, Aurora, Ind. 5-15-1

EMPLOYER AND EMPLOYEE at that critical moment when each needs the other find Efficient Service Co., 1340 Monadnock Bldg, Chicago, Ill., "Efficient." R. E. Plumbe, Pres. Write for evidence. tf.

POSITION WANTED—As engineer or switch-board operator in large station. Have eight years experience in power station, with high and low speed engines. Direct and alternating current generators. Prefer middle or western states. Address Box 293, Practical Engineer, Chicago, Ill. 5-15-1

POSITION WANTED—By first class gas engineer. A. and D. Current. Can give results and best reference. Sober and steady. Third year present plant. Address Box 296 Practical Engineer, Chicago, Ill.

POSITION WANTED—As chief engineer, age 31; married, understands electric machine, mechanical drawing, first class Ohio license; can give reference. Wages depend on the cost of living at that place. Address, Box 292, Practical Engineer.

Wanted

WANTED—ENGINEERS and Mechanics to use and sell my calipers and levels; liberal inducements. Ernst Smith, Columbia, Pa. 5-15-1

AMERICAN SERVICE CO., Pittsburgh, Pa., require records of engineers, superintendents and production clerks for executive and shop vacancies. 5-1-2

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No 317 Norfolk Ave., Buffalo, N. Y. tf.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

Help Wanted

DETROIT MANUFACTURERS of Boiler Specialties have an opening for a sober, aggressive type of engineer who thinks he would make a good salesman. We want a man of good appearance, a good talker, with a wide acquaintance among engineers in your territory. This is an unusual opportunity for a permanent connection with an old established business, on a very attractive basis. Address, Box 305, Practical Engineer, Chicago, Ill. 5-15-3

RESIDENT SALES MANAGER to sell Tidman's Reinforced Hollow Concrete Poles and State Rights. Calling only on steam and electric railways, telegraph, telephone, gas and power lines; states, counties and cities for ornamental purposes. No competition. Endorsements of highest class engineers. No experience needed. To result getter, income very large. Permanent future. State what territory and submit references. 941 Monadnock Bldg., San Francisco. 5-1-2

WANTED—An additional subscription solicitor wanted to cover towns in state of Washington. Excellent chance to earn extra money., Write to Subscription Department. tf.

For Sale

FOR SALE—A double tandem automatic gas engine, 250 H.P. on natural gas, or 200 H.P. on producer gas. We are prepared to over a great bargain. Phoenix Iron Works Co., Meadville, Pa. 5-15-3

CLOSING OUT ENTIRE line of Stickney engines. Brand new and guaranted by the manufacturers: List price less 25 per cent F. O. B. Bridgeport. Sizes 1¾—5—7 hp. Waldorf Motor & Machine Co., 135 Cannon St., Bridgeport, Ct. 5-15-1

FOR SALE—14-32 Watts Campbell Corliss engine, seen running until May 1st; condition like new, $600. Duzets & Son, 40 Church St., New York. tf.

Patents and Patent Attorneys

PATENTS SECURED—Send sketch or model for search. Book containing over 200 mechanical movements, advice and search free. W. N. Roach, Jr., 515 Metzerott Building, Washington, D. C. 5-15-7

PATENTS WITHOUT ADVANCE attorney's fees. Send sketch for free report. Books free. Fuller & Fuller, Washington, D. C. 5-15-2

LAWRENCE J. GALLAGHER, formerly assistant examiner United States Patent Office; solicitor of patents. 2 Rector St., New York. 5-15-3

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G St., Washington, D. C. 5-1-2

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books, R. B. Owens, 28 Owens Bldg., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

"PATENT PROFIT from Patton Service," is the title of our instructive booklet for inventors; sent free upon request. Strong patents that legally protect are our specialty. Send sketch or model today. Harry Patton Co., 330 McGill Bldg., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gild edges, bound in leather. tf.

Miscellaneous

IF YOU ARE an operating engineer, we know the Fetta Hot Process Water purifier will interest you. We would be glad to have your request for further information. Address the Fetta Water Softener Co., Richmond, Ind. tf.

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf.

Sparks From The Advertising Pages

A salesman's curiosity was aroused in one of the power plants he visited recently, by the sight of a shelf filled with old copies of Practical Engineer. "Why do you keep all of those old magazines?" he asked. "You don't read them, more than once, do you?"

"I read some of them several times over," the engineer answered, "and most of them are fingered over more than once each year. That shelf is my library. Those magazines contain the very *meat* of knowledge essential to my position. *Their advertising pages are valuable as a buying guide.* I frequently refer to them here at the plant and often take some of them home to read during the evening."

All honor to this engineer. He appreciates the responsibility and confidence that his firm has placed in his judgment and he utilizes his spare moments in reading to educate that judgment to be *right.*

At night, under the evening lamp, in the cheerfulness of his home, he builds the foundation of his future value to employer, world, and himself. He explores the advertising pages for new knowledge. He forms his opinions and decisions regarding the value of machines and materials on *worth*—when he has no voluble salesman at his elbow, urging a decision, or to cover *deficiencies* with *glibness.*

Preparation is the forerunner of *success.* Gorgas, who transformed swampy Panama into a livable land; Hobson who sunk the Merrimac in the entrance of Santiago Harbor; and Eads whose jetties keep the Mississippi river navigable at her mouth, were men whose *preparation* enable them to give *valuable service,* when needed.

Men of the right stamp keep step with Time. They fortify themselves against the *unexpected* as well as the *regular.* They are *worth while.*

Such a man is John Craig Scott, Pittsburgh, Pa. He had a big job on his hands. How he prepared for it, he tells in this paragraph taken from his letter concerning Practical Engineer.

"Though of late, on account of being in charge of the installation for a complete new power plant in our new factory, I must say the advertising pages have received more attention from me in the past six months than any other part, and no one can estimate the help these pages have been to me in selecting steam and electrical appliances best suited to our requirements. 'It pays to advertise' is an old saying which is generally understood to mean from the manufacturer or the agent; but I think the biggest dividends from advertising are unknowingly reaped by the reader —both from an educational as well as economical point of view."

Are you a Scott, a Gorgas, an Eads or a Hobson? Would you know where to buy the right material from boiler to oil can if you were called upon to purchase the complete outfit for a new power plant, right now?

To know, how, when and where to buy, is *essential knowledge.* This is the day when *employers* are convinced by *dollars-and-cents results.*

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